PRINCIPLES

OF

FORENSIC MEDICINE.

PRINCIPLES

OF

FORENSIC MEDICINE.

BY

WILLIAM A. GUY, M.B. CANTAB.
F.R.S.

FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS;
PROFESSOR OF FORENSIC MEDICINE, KING'S COLLEGE, LONDON;
PHYSICIAN TO KING'S COLLEGE HOSPITAL;
ETC. ETC.

THIRD EDITION,

CORRECTED, ENLARGED, AND COPIOUSLY ILLUSTRATED BY WOOD ENGRAVINGS.

HENRY RENSHAW,
356, STRAND, LONDON.
1868.

LONDON:
SAVILL AND EDWARDS, PRINTERS, CHANDOS STREET,
COVENT GARDEN.

PREFACE

TO

THE THIRD EDITION.

THE original aim of the author in undertaking this work, was to furnish for teacher and learner alike a convenient Text-book—that is to say, a book in which principles and results should be clearly and briefly stated, disencumbered of minute details of the steps and processes by which they were obtained ; and containing only such illustrative cases as could be compressed into a very narrow compass.

But the brevity and condensation which such an aim presupposes, were found quite consistent with an original treatment of several subjects, and with an elaborate analysis of facts which others had collected with much labour, but had left undigested, and therefore useless or misleading. Of such elaborate analysis, the first edition of this work contained several examples, under the heads of Personal Identity, Infanticide, Legitimacy, and Unsoundness of Mind.

When the time for preparing a second edition had arrived, some of these tabular expositions and condensations, having served the purpose for which they were designed, and demonstrated the uselessness of certain tests and standards of comparison, were omitted. Many illustrative cases were also either curtailed or set aside, and room was thus left for a considerable number of engravings, of which the greater part were drawings of seeds, structures, and chemical reactions as seen under the microscope.

The second edition thus became the first methodical English treatise on Forensic Medicine, in which such illustrations were largely used; at the same time that it contained some new chemical facts and tests, arising out of the method then recently suggested by the author, of obtaining sublimates of the more important mineral poisons, especially arsenic and mercury, on a flat surface of glass, so as to admit of ready examination by the microscope.

In this, the third edition, the original aim of the book has not been lost sight of, while the principle of pictorial illustration has been carried much farther than in any similar work. The additional woodcuts have been in part rendered necessary by the interesting discovery of Helwig, of Mayence, that the method of sublimation on flat surfaces admitted of extension to the alkaloids. The results obtained by this means (so easy of application in all cases, productive of such characteristic appearances in many), are now for the first time described and illustrated; and new diagnostic methods, as well as distinctive tests for some important poisons (especially strychnine, morphine, and cantharidine) are pointed out.

The present edition, then, while it retains its first character of a text-book, has many attributes of an original work. The new matter is to be found not only scattered through the whole subject of Toxicology, but specially embodied in the chapter on Methods of Procedure (p. 367), and in the final chapter on the Diagnosis of the Poisonous Alkaloids and Analogous Active Principles.

The woodcuts, nearly 200 in number, illustrate a much larger number of objects. A few (being cuts of poisonous plants) have been placed at my disposal by the publisher. The remainder, with very few exceptions, have been drawn and engraved by Mr. Hart—the drawings of microscopic objects being faithfully copied from specimens placed in the hand-microscope, or from photographs taken by my friend Dr. Julius Pollock, to whom I take this opportunity of expressing my many obligations. In preparing the drawings of the poisonous plants, use has been made of the works of Orfila, and Tardieu, and the 'Medical

Botany' of Churchill and Stephenson; the illustrations in the Chapter on Pregnancy are taken chiefly from Dr. Arthur Farre's exhaustive treatise on the uterus and its appendages reprinted from the 'Cyclopædia of Anatomy and Physiology'; and those of Unsoundness of Mind are after lithographs kindly presented to the author by the late Sir Alexander Morison.

The works to which, in this edition, it is proper to refer, as having been much consulted, and sometimes quoted, are Casper's "Handbook of the Practice of Forensic Medicine," translated for the New Sydenham Society, by Dr. G. W. Balfour; the "Manuel complet de Médecine Légale," by MM. Briand and Chaudé; the "Etude Médico-légale et clinique sur l'empoisonnement," of Tardieu and Roussin; "Das Mikroskop in der Toxicologie," of Dr. A. Helwig; the "Micro-Chemistry of Poisons," by Wormley; the "Principles of Chemistry," of Naquet; and the "Chemistry, Inorganic and Organic," of Bloxam.

26, Gordon Street,
June, 1868.

CONTENTS.

PART III.

Toxicology.

Inorganic Poisons.

Organic Poisons.

LIST OF WOOD ENGRAVINGS.

PRINCIPLES

OF

FORENSIC MEDICINE.

INTRODUCTION.

The State avails itself of the knowledge, experience, and skill of the medical man for three distinct purposes:—1. For the care and treatment of soldiers and sailors, prisoners, paupers, lunatics, and other classes of persons for whose safety it makes itself responsible; 2. As officers of health; and 3. As skilled witnesses in courts of law.

The duties which the medical man has to perform in the first of these capacities do not differ materially from those which devolve upon him in the ordinary practice of his profession, except that he is expected to give attention to the prevention as well as the cure of disease, and to add to professional skill administrative talent.

But as officers of health, and witnesses in courts of law, medical men have duties to perform for which the ordinary practice of the profession affords no adequate preparation, medical education, till of late years, no proper training, and medical literature no sufficient guidance.

A consciousness of the distinctness, importance, and difficulty of these duties led at length to the establishment of a distinct science, taught in separate courses of lectures, treated of in separate works, and engaging the attention of men more or less completely separated and set apart for the practice of the corresponding art.

This new science either embraced the whole of the duties which the medical man may be required to perform on behalf of the State, in which case it received the name of Political, or State-Medicine; or it was divided into two sciences, the one under the title of Hygiène or Public Health, the other known

indifferently as Forensic Medicine, Juridical Medicine, Legal Medicine, or Medical Jurisprudence.

As the term FORENSIC MEDICINE expresses as clearly as any other the application of medical knowledge to legal purposes, it is used in the title of this work. The term *medico-legal* is also in common use, as in the phrases "medico-legal knowledge," "medico-legal experience," "medico-legal skill."

The history of Forensic Medicine resembles that of most other sciences. Necessity or convenience first gives birth to an art practised by persons more or less skilful without any guidance from general principles; but its importance, and the responsibility attached to the practice of it, soon create a demand for instruction, oral and written, which gradually assumes a systematic form. Thus it was that the science of medicine sprang from an empirical art of healing; and in like manner the science of Forensic Medicine took its rise in the necessity of bringing medical knowledge to bear on legal inquiries relating to injuries or loss of life; the medical witness being at first without guidance in the performance of his duty, and so continuing till a growing sense of its important bearings on the interests of society, and on his own reputation, created a demand for instruction which could not fail of being supplied. Cases were accordingly collected, arranged, and commented on, illustrative facts sought after, special experiments devised and performed, till at length the medical witness received in books and lectures the same distinct instruction as the physician or surgeon at the bedside had already derived from written or oral teaching in the theory and practice of medicine, or of surgery.

But the importance of medical testimony received an earlier recognition from some of the continental governments than from the public or the medical profession; for the first medico-legal treatise (1597) was anticipated by nearly a century by the earliest State recognition (1507). The first systematic appointment of medical men to perform medico-legal duties seems to have been made in France in 1603.*

* The following dates have an historical interest. The penal code of the Bishop of Bamberg, proclaimed 1507. A uniform penal code adopted by the Diet of Ratisbon, 1532. The *Constitutio Criminalis Carolina*, published 1553. Presentation by Henry IV. of France of letters patent to his first physician, empowering him to appoint two surgeons in every city and large town to examine and report upon wounded or murdered persons, 1603. Publication at Frankfort of the Methodus Testificandi of Condronchus, 1597, and of the works of Fortunatus Fidelis and Paul Zacchias in 1598 and 1621. First course of lectures on Forensic Medicine given by Michaelis at Leipzig, about 1650. For a learned history of legal medicine, see Traill's 'Outlines of Medical Jurisprudence.'

The history of Forensic Medicine as a science in England is of comparatively recent date. It begins with the publication, in 1788, of Dr. Samuel Farr's 'Elements of Medical Jurisprudence.' It was first taught in lectures at Edinburgh, in 1801, by Dr. Duncan, sen., and the first professorship was conferred by Government on his son in 1803. The new science soon justified the distinction conferred upon it, and made good its claims to more general recognition. It now enters into the curriculum of most of the examining bodies; it is taught in all our medical schools; its principles are being constantly applied in our courts of law; and England is contributing her fair share of observation and research towards its extension and improvement.

The application of the principles of the science—in other words, the practice of it as an art—devolves, for the most part, on the medical practitioner. It is only occasionally that those who devote special attention to the entire subject, or to important parts of it, such as Toxicology, or who attain to eminence in special branches of medical practice, such as midwifery and the treatment of the insane, are summoned to give evidence.

There are many reasons why the medical man should approach the performance of this class of duties with apprehension. He is conscious of the importance which attaches to his evidence; he is wanting in the confidence which a more frequent appearance in the character of a witness would impart; he is painfully alive to the unstable foundation on which many medical opinions rest; he knows that it is not easy in practice to observe the rules of evidence with which in theory he may have made himself acquainted; and, above all, he shrinks from the publicity which attends all our legal proceedings, and from the unreasonable licence allowed to counsel engaged not to discover truth but to achieve victory. Sympathizing in these reasonable apprehensions, some medical writers of eminence and most authors on Forensic Medicine have endeavoured to prepare the medical witness for his duties by setting forth the precautions he should observe both prior to and during his attendance in court. The best mode of conducting medico-legal inquiries is generally pointed out under the heads of "Post-mortem inspection," "General evidence of poisoning," "Unsoundness of mind," &c., while the precautions to be observed in the witness-box are the subject of distinct treatment under the title Medical Evidence. This distinction is observed in these pages.

Before proceeding to treat of the duties of the medical witness, it may be well to give some idea of the number of cases occurring year by year in England and Wales of a class to give

rise to medico-legal inquiries. The Twenty-seventh Annual Report of the Registrar-General for the year 1864, records the following figures :—

Deaths by accident or negligence . .	15,097
„ „ suicide	1,340
„ „ murder and manslaughter . .	412
Other violent deaths (not classed) . .	154
	17,003
Sudden deaths (causes unascertained) . .	3,321
	20,324
Premature births, malformations, atrophy and debility	39,270
Total . . .	59,594

The following are some of the special causes of death comprised in the first two lines of the foregoing table.

Causes of Death.	Accident or Neglect.	Suicide.	Total.	Males.	Females.
Poison	274	154	428	236	192
Fractures and bruises . .	6500	—	6500	5559	941
Gunshot	126	65	191	175	16
Cuts and stabs	115	249	364	281	83
Burns and scalds	2987	—	2987	1475	1512
Drowning	2714	205	2919	2373	546
Hanging	—	564	564	452	112
Suffocation	1245	—	1245	744	501
Lightning	6	—	6	6	—
Total	13,967	1237	15,204	11,301	3,903
Otherwise	1130	103	1233	903	330
Grand Total	15,097	1340	16,437	12,204	4233

The deaths by accident or negligence were distributed between the sexes as follows :—Poison, men 149, women 125; Gunshot, men 111, women 15; Cuts and stabs, men 87, women 28; Drowning, men 2250, women 464; otherwise, men 830, women 300.

The suicides were distributed as follows :—Poison, men 87, women 67; Gunshot, men 64, women 1; Cuts and stabs, men

1941, women 55; Drowning, men 123, women 82; Hanging, men 452, women 112; otherwise, men 73, women 30.

The premature sudden and violent deaths gave rise to 25,011 inquests, of which 17,566 on the bodies of males and 7445 on those of females: and as the qualified practitioners in England and Wales fall far short of this number, it follows that, if the duty of attending at inquests were distributed equally, each member of the profession would attend at least one inquest every year.

The committals for trial arising out of these 25,011 inquests amounted to 509, of which 227 were for murder, and 282 for manslaughter. In 1397 instances the death was returned as suicidal.

The number of cases requiring medical evidence in our higher courts of law may be judged of approximatively from the printed returns of commitments for trial for offences against the person. In the year 1865 these amounted to 2062, and comprised 155 murders and attempts to murder; various attempts to maim and injure, 481; assaults, and inflicting bodily harm, 646; manslaughter, 164; attempts to procure abortion, 5; concealment of birth, 108; rape and assaults with intent, 385; unnatural offences, and assaults with intent, 118. If we add to the occasions for medical evidence arising out of the events above recorded, the civil cases in which skilled medical evidence is required, and proceedings in respect of lunatics, the occasions on which medical men are summoned to courts of law, either in the service of the State, or on behalf of individuals, will appear very considerable—certainly numerous enough, and important enough in themselves, to justify all the attempts which have been made to construct a science of Forensic Medicine, to teach it systematically in books and lectures, and to draw up a code of instructions for the guidance of the medical witness in the performance of his duties.

MEDICAL EVIDENCE.

The medical man, when summoned as a witness, may have to *state* facts, and to *interpret* them. In the one case he is called a *common* witness, in the other a *skilled* witness, or *expert*.

He is examined as to the facts he has witnessed, and he is also questioned as to his interpretation of them. In the majority of cases he acts in both capacities.

In stating facts, and in drawing inferences from them, or from the evidence of others, there are certain precautions which the witness ought to observe, and certain legal requirements of which he should not be ignorant.

1. He should "use his best endeavours that his mind be clear and collected, unawed by fear, and uninfluenced by favour or enmity." (Percival.) He will not find it easy to maintain this impartial frame of mind when the crime alleged is one of unusual enormity; when popular feeling runs high either for or against the accused; or, in times of public agitation, when a popular movement may seem to be endangered by evidence given in favour of an individual. Nor, when he is engaged, as a skilled witness, or *expert*, for the prosecution or for the defence, must he deem himself free from the risk of partiality, even though, after hearing all the facts upon which his opinion must be formed, and making proper personal inquiries, he feels that he can conscientiously give his evidence in favour of the party for whom he is retained.

2. The medical witness requires to be specially cautioned against expressing an opinion on the general merits of the case under inquiry, thus offending against an admitted principle of English law, that "when scientific men are called as witnesses, they are not entitled to give their opinion as to the *merits of the case*, but only as to the *facts proved on the trial*."

3. A special caution is also required against indulging a feeling of misplaced humanity, or an equally misplaced condemnation of the law on the score of undue severity. Both these feelings too often found expression in former treatises on the lung-tests, and earlier trials for infanticide. But the medical witness should understand, and bear in mind, that he is not responsible for the consequences to which his opinions may lead, provided always that they are the result of cautious inquiry and due reflection. Dr. Percival accordingly treats "The dread of innocent blood being brought upon us by explicit and honest testimony," as "one of those superstitions which the nurse has taught, and which a liberal education ought to purge from the mind."

The medical witness approaching his duties with a mind thus free from bias, requires some instruction as to the mode in which his evidence should be given.

1. Bearing in mind the distinction already laid down between a common witness and a skilled witness, he should be cautious not to obtrude his opinions when facts only are required of him, nor dogmatically to assert as facts things which are merely matters of opinion. He should answer the questions put to him, whether by counsel, court, or jury, clearly and concisely, and if these do not elicit the whole truth, he must supply what is wanting.

2. His statements should be made, and his opinions expressed, in the plainest and simplest language; and he should avoid as much as possible all technical terms, and all figurative and metaphorical expressions.

3. The medical witness ought also to abstain from quoting authorities in support of his opinions; for though the rule of exclusion has not always been rigidly acted on, the common usage of our courts of law is certainly to disallow these appeals.

Nor is this exclusion open to any serious objection, for the witness is supposed to make himself master of the views of the most eminent writers on the subject-matter of his evidence, and to use them as aids and guides to his own special inquiries.

But though the witness may not cite authorities, he may be asked whether A or B is an esteemed authority with his profession, and whether he (the witness) coincides with some opinion expressed in his works. If the witness answers in the affirmative, he becomes the exponent of the opinion to which he thus gives his assent.

The foregoing observations relate chiefly to the mode in which the witness should give his evidence. The precautions to be observed in order that his evidence may be admissible still remain to be considered, under the following heads:—

1. *Notes.*—When observing any facts which, at a future time, may become the subject-matter for legal inquiry, the medical man should not trust to his memory, but commit them to writing, either on the spot, or as soon as possible after the transaction to which they relate. If (as in performing a post-mortem examination) it is necessary to resort to dictation, the notes of the amanuensis should be immediately examined and corrected.

The witness may use these notes in court to *refresh* his memory, but not to supply its place. If the notes were not made till some time after the events to which they refer, or if, having

been made at the proper time, they have been entirely forgotten, they will not be admissible.

2. *Confessions.*—A culprit may make a confession of guilt to his medical attendant, and it is well that he should know that, to be admissible in a court of law, it must be free and voluntary, uninfluenced by threat, promise, or inducement. The medical man, then, if asked to receive a confession, must hold out no sort of inducement to make it, he should put no leading questions, and make no comments, but should reduce the statement to writing as soon as possible, read it over to the person confessing, obtain his signature to it, and countersign it himself.

At the same time the greatest care should be taken to ascertain the bodily health and mental condition of the party making the confession. The necessity of this caution has been amply proved by cases in which, under the influence of fever, or, as the result of prolonged exposure and hardship, confessions have been made of murders and other heinous crimes which had never been committed. In times now happily passed away, innocent persons, under like conditions of body and mind, made confession of impossible crimes, such as witchcraft.

3. *Death-bed Declarations.*—These are admitted as evidence in cases of homicide, where the death of the deceased is the subject of the charge, and the circumstances of the fatal injury the subject of the declaration. It is assumed that the declarant, having lost all hope of recovery, is induced to speak the truth by considerations as powerful as an oath administered in a court of justice. It is not necessary, however, that he should *express* his conviction. It may be inferred from the nature of the injury, or from other circumstances of the case. But if any hope whatever be entertained, or may be inferred to exist, whether it be spontaneous or on the suggestion of others, death-bed declarations cannot be received in evidence.

But the person, or persons, inculpated by the declarant's statement, are not precluded from giving evidence as to his state of mind and behaviour in his last moments. They may be allowed to show that the deceased was influenced by vindictive motives, or was not of a character to be "impressed by a religious sense of his approaching dissolution."

As dying declarations are but confessions of the most solemn kind, it is easy to point out the course which the medical man ought to adopt when called upon to receive them. He should put no leading questions, but restrict himself to inquiries necessary to clear up ambiguity. He should commit the declaration to writing, read it to the dying man, and obtain his assent, and,

if possible, his signature to it. But if the declarant's death take place so soon that there is no time for this, he should make a memorandum of the declaration at once, while it and the words used are fresh in his memory. To this document the witness will be allowed to refer to refresh his memory when he comes to give evidence. Another essential part of his duty is to ascertain the exact state of the declarant's mind, whether he is calm and collected, or otherwise, and whether he is under the influence of any strong bias, or undue feeling of resentment.

4. *Hearsay.*—This is not admissible as evidence unless it form part of the *res gesta.* A medical witness, therefore, though he may state in evidence the words he has heard used in direct reference to the case which forms the subject of inquiry, could not cite a case in support of his opinions, if it consisted in part, as it must needs do, of statements made by the patient, his friends, or attendants.

5. *Secrets.*—The medical man, in the course of his professional attendance, may receive secret information which, under ordinary circumstances, he would be bound not to divulge. But it should be understood that in a court of justice he may be compelled to divulge these secrets.

It is now no longer necessary to warn the medical man against taking part in duels, even though his object in being present at them is to save life, and not to destroy it. But if in this, or in any other way, he has acted illegally, he, in common with other witnesses, is not obliged to give evidence which may tend to criminate himself.

6. *Wills.*—It occasionally happens that a medical man is called upon on an emergency, to draft the will of a patient, or to act as one of the witnesses to the instrument; and he should be prepared for such a contingency. In taking the instructions of the testator, he should limit himself to such inquiries as may enable him to understand his wishes. He should write them down in the fewest, simplest, and clearest words on one side of a sheet of paper, append the place and exact date of the transaction, and at the foot of the document (leaving room for the necessary signatures) the following words :—

"Signed by the above-named testator, in the presence of us present at the same time, who have hereunto signed our names as witnesses thereto, in the presence of the said testator, and in presence of each other."

The testator and witnesses must attach their signatures in accordance with these words. The medical man should take care to observe the condition, bodily and mental, of the testator,

and he would do well to make a note of all the circumstances of the case while they are fresh in his memory. Wills so made have been disputed, and the medical man has been summoned as a witness, and submitted to a searching examination.

Consult on this subject, Philips and Starkie on Evidence; An Analysis of Medical Evidence, by John Gordon Smith, M.D.; Amos's Lectures in the 7th volume of the Medical Gazette; Percival's Medical Ethics; Archbold's Summary of the Law relative to Pleading and Evidence in Criminal Cases. Also Burn's Justice, by E. V. Williams, title Evidence.

PART I.

CHAPTER I.

PERSONAL IDENTITY. AGE. SEX.

These three subjects are thrown into one group, as having a close connexion with each other. When the body of some unknown person is found, or the remains of one, we may have to ascertain the sex and the age, and then to identify the individual by characteristic marks. These questions may also be raised separately. They are treated of in this Chapter in the most convenient order, Sex occupying the last place, from its connexion with the topics contained in Chapter II.

PERSONAL IDENTITY.

Questions of identity are often raised in courts of law; as when a child claims an inheritance, a man who has been robbed is required to identify the thief, or a witness is examined as to the identity of a person with whom he is acquainted. A jury may also be empannelled for the sole purpose of trying the question of identity, viz., when a prisoner after conviction makes his escape and is retaken. The question may also be raised as to persons found dead; and in coroners' inquests the first step taken is to identify the body or such parts of it as may be found.

The subject of personal identity, then, divides itself into 1, *The Identity of the Living;* and 2, *The Identity of the Dead.*

I. IDENTITY OF THE LIVING.

The medical man is not often called upon to assist in identifying living persons. But when there are deformities or injuries he may be consulted as to their nature and cause; as also when changes of colour have been brought about in the skin or hair. But in

order to give completeness to this subject, some questions will be briefly noticed which do not require medical evidence for their solution.

In the case of parties claiming inheritance, much stress has been laid on family resemblance. In the celebrated Douglas Peerage case, Lord Mansfield said, "I have always considered likeness as an argument of a child's being the son of a parent. A man may survey ten thousand people before he sees two faces perfectly alike, and in an army of one hundred thousand men every one may be known from another. If there should be a likeness of feature, there may be a discriminancy of voice, a difference in the gestures, the smile, and various other things; whereas, a family likeness runs generally through all these, for in everything there is a resemblance, as of features, size, attitude, and action." This case was decided in favour of the claimant, Archibald Douglas, in consequence of his proved resemblance to Colonel Stewart, his father. The twin brother, Sholto, who died young, was proved to have equally resembled Mrs. Stewart, the mother.

On the other hand, persons having no connexion by relationship or descent may bear the closest resemblance to each other, as in the following remarkable example:—In the year 1772, Mall, a barber's apprentice, was tried at the Old Bailey for robbing a Mrs. Ryan. The witnesses swore positively to the identity of the lad, and the whole court thought him guilty. But his innocence was proved by referring to the books of the court, from which it appeared that on the day and hour when the robbery was committed he was on his trial at the bar where he then stood for another robbery, in which he was likewise mistaken for the thief.

The question of identity of persons claiming inheritance may also resolve itself into a consideration of the change which the lapse of time, coupled with fatigue, hardship, and privation, may produce in the personal appearance. Cassali, a noble Bolognese, left his country at an early age, and was supposed to have lost his life in battle; but, after an absence of thirty years, returned and claimed his property, which his heirs had appropriated. But the change in his appearance was so great that he was imprisoned as an impostor. The judges, being in doubt, consulted Zacchias, who in his report mentioned several causes which might produce such a change, as age, change of climate, diet, mode of life, and disease. Cassali had left home in the bloom of youth, had been exposed to the hardships of a military life, and if the claimant might be believed, had languished for years in prison. As the heirs could not prove the death of Cassali, the judges, influenced by the opinion of Zacchias, decreed the restoration of his estates.

The question of identity assumes a more complicated form when some person resembling the true claimant is put forward to contest his right. The reader will find illustrations of this fraud in the cases of Baronet and Martin Guerre, which, with that of Cassali, just cited, and other leading cases from the 'Causes Célèbres,' are quoted and criticised by Foderé in the second chapter of his 'Traité de Médecine Légale.'

Many cases of disputed identity have been decided by means of peculiar personal marks, such as nævi materni, moles, deformities, or the scars of foregone disease or injury, on which medical men were required to state their opinion. Even these personal marks, however, may, by strange coincidence, be present in two individuals otherwise closely resembling each other. Thus, Joseph Parker, tried at New York in 1804, for bigamy, not only bore a near resemblance to one Thomas Hoag, for whom he was mistaken, but had in common with him a scar on the forehead, a small mark on the neck, and a lisp in his speech; but, unlike Hoag, he had no scar on his foot. That he was Joseph Parker, and not Thomas Hoag, was proved to the satisfaction of the jury by an alibi. (Beck. Age and Identity.)

In a Belgian case which occurred in 1847, a question of identity turned in some degree on the possibility of removing scars. One medical man, M. Vandelaer, stated that scars might be removed by time or by artificial means, and the physicians of the prisons of Valvorde and Ghent confirmed this opinion by stating that prisoners are in the habit of effacing scars by applying a salted herring to them. MM. Lebeau and Limanges, on the other hand, contended that scars could not be removed; and their opinion is doubtless the correct one, though scars certainly grow less distinct with the lapse of time. The belief that they may wholly disappear is probably founded on the very slight marks left by extensive wounds when they heal by what is technically called the "first intention." Thus, in the case of a maniac who had completely removed the parts of generation, the situation of the wound was marked by a faint white line which might be overlooked by a casual observer; and the severe floggings of former times, which left the back quite raw, are traceable after some years only by very fine white lines upon the back and sides, and, where the knots had fallen, by little circular pits. In a case in which we were consulted, the entire absence of both kinds of mark enabled us to state with confidence that the man could not have been, as was alleged, very severely flogged. The same remarks that apply to ordinary scars may be extended, with some exceptions, to the brand of the deserter, and the blue and red figures produced by

the process of tattooing. The great majority of tattoo-marks are found to be indelible. But those which are coloured with cinnabar and blue ink are less permanent than those for which Indian ink, soot, or washing blue have been used. In consequence, probably, of the use of such different colouring materials, the three leading observers in this direction (Casper, Hutin, and Tardieu) have arrived at results somewhat different; the first two having found the marks obliterated in about 1 in 10, the last in about 1 in 25. Sometimes it appears that the colouring matter may be traced into the absorbent glands. In one instance Tardieu, following the instructions of a prisoner, succeeded in removing a crucifix tattooed in Indian ink by successive applications of acetic acid, liq. potassæ, and weak muriatic acid.* Scars which have become faint or scarcely visible, by the lapse of time, may be rendered distinct by friction. The scar retains its pale colour, while the surrounding skin reddens.

It will therefore be inferred that the exact shape of a scar may render great assistance in determining a question of identity. Thus the operations of bleeding, cupping, and vaccination, like the punishment of the lash, leave appearances difficult to confound with those due to any other cause. So also with the scars of scrofulous ulcers on the neck, of lupus on the face, of small-pox on all parts of the body, and of burns and caustic.

Identification is sometimes effected by comparing a recent wound with the part detached from it. In January, 1846, a robbery was committed at Stigny, in the house of two old men. The next morning several spots of blood were found on the floor on the left of a chest of drawers which the robbers had forced. Other spots, resting on the snow that had fallen the previous night, were found following the direction taken by the robbers when they quitted the house, and always on the left-hand of the footsteps. A shred of membrane was also found on the road, which on examination proved to be a portion of skin. On searching the neighbourhood, a man was found with his *left*-hand wounded. Dr. Lemoine and M. Cœurderoi were appointed to examine him; and both agreed that the wound was probably inflicted about the date of the robbery, and that the piece of skin, judging from its size and shape, had formerly covered the injured part. The accused confessed the crime. (Annales d'Hygiène, Jan. 1847.)

Fraudulent discoloration of the Hair.—The question whether it is possible to turn the hair from dark to light was raised in

* Consult Casper, vol. i. p. 105.

Paris in 1832, on the occasion of the trial of one Bénoit for murder. Certain witnesses deposed to having seen him in Paris at 2 p.m. with black hair; while others declared that they saw him at Versailles, at 5 or 6 o'clock the same evening, with fair hair. The man's natural hair was jet black, and it does not appear that he wore a wig. The tribunal consulted Orfila, and Michalon, one of the first hair-dressers of Paris, as to the possibility of changing the hair from dark to light? Michalon replied in the negative; but Orfila declared that it was possible, for that as early as the year 1806, Vauquelin had read at the Institute a *mémoire* on the property which chlorine has of giving to black hair all the lighter colours, and even of bleaching it.

This case led to careful experiments by Orfila, and subsequently by Devergie. Orfila examined the mode of turning the hair from light to dark, from dark to light, and from light red or chestnut to other shades of colour. Devergie limited himself to the verification of Orfila's experiments on the effect of chlorine on the hair.

1. The following are modes of changing the hair from light to dark.

a. Charcoal and grease.—This is easily detected by its soiling the fingers for days after its application; and by placing a lock of the hair in boiling water, when the grease swims, and the charcoal falls to the bottom.

b. Salts of bismuth, lead, and silver.—The hair, previously freed from its oil by liquor ammoniæ, is moistened with a solution of one or other of these salts, and then steeped for a quarter of an hour in sulphuretted hydrogen water. The black sulphides formed by this process may be detected by steeping a lock of hair in dilute nitric acid, and testing for the base.

A mixture of litharge, chalk, and lime, in nearly equal proportions, dissolved in water, was found very effectual. The hair was kept moist with it for three or four hours, and then allowed to dry. The chalk and oxide of lead were next removed with dilute acetic acid, and, lastly, the hair was rubbed with yelk of egg. The colour was thus effectually changed without any injury to the texture of the hair. These ingredients in proportions varying according to the degree of change desired, compose the *Tinctura Pompeiana* of the shops. By steeping the hair in dilute nitric acid, the ingredients of this mixture are dissolved with effervescence, leaving the nitrates of lead and lime in solution.

2. Mode of changing the hair from dark to light.

The results of numerous experiments made by Orfila and Devergie with solutions of chlorine of different strengths, may be

thus summed up. Black hair may be changed to various lighter shades, as dark and light chestnut, dark and light blond, yellow, and yellowish white, by being steeped or washed a longer or shorter time in solutions of chlorine of different strengths. But Orfila erred in supposing that the marked effects produced by soaking the hair in a solution of chlorine could be obtained by merely combing it with that fluid, for hair so treated is but slightly changed even after many repetitions of the process. The chlorine is readily detected by its odour, even after washing the hair as many as fifty times with water; the colour of the hair is peculiar, by no means uniform, and not easily confounded with any natural colour; and the hair itself is hard, stiff, and brittle. These results are in strict accordance with those of my own experiments. Better results are obtained with nitric and nitro-muriatic acid, which diluted with 50 times their bulk of water, are found to give a golden tinge to dark hair. All these processes occupy some time; and the fraud would be easily detected by allowing the hair to grow, taking care that the suspected person had no access to any dye; or the shorter process of analysis might at once be used.

It may be well to state in this place that the hair undergoes a marked change of colour in the course of some processes of manufacture. In turning rulers, for instance, out of the wood known as "green ebony," light hair is permanently changed to green, and a similar change results from working in an atmosphere containing copper in fine division.

The effect of sudden and violent emotion in turning the hair gray is well known. Such quick change of colour may also be produced by disease and other obscure causes. One remarkable case of complete change of colour in the hair of the whole body is related by Dr. Gordon Smith. It took place in a girl thirteen years of age in a single night, without being preceded by any indisposition or by any emotion which could account for it. The change thus produced is sometimes permanent: but in some cases the colour of the hair has been restored.

One other question relating to the identity of the Living remains to be examined, viz., *What degree and duration of light are necessary to enable an observer to distinguish the features, so that the person may be afterwards identified?* That a very short duration of a brilliant light is sufficient for this purpose will appear from the following case:—A lady, on her passage from India, awoke in the middle of a dark night, and heard some one stirring in her cabin. The sudden illumination of a flash of lightning enabled her to see distinctly a man rummaging one

of her trunks, and to discern his features, so as to identify him next morning. Some of the stolen things were found upon him, and he acknowledged the fact.*

In a case which occurred in France about half a century ago, the question was raised whether the light produced by the flash of a pistol was sufficient to discover the face of the person firing.

The Sieur Labbe, one dark night in the month of May, 1808, was riding along the highway with the widow Beaujean, when his servant, who was on foot, was wounded in the hand by a gun fired through a hedge bordered by a ditch. Both master and servant swore that they recognised the assassin by the light of the discharge. One of the accused was arrested, tried, and condemned to death; but an appeal being taken to the Court of Cassation, Gineau, Member of the Institute, and Professor of Experimental Physics in the Imperial College of France, was consulted as to the possibility of an identification in the manner described. Accordingly, Gineau, his son, Professors Dupuis and Caussin, and several others, caused several primings to be fired in a dark room, the spectators being stationed at different distances, to witness the effect. The light produced was strong, but fuliginous, and so transient that "it was scarcely possible to see distinctly the form of a head, and that of the face could not be recognised." The experiments were then repeated in the court-yard of the college, the gun being loaded with powder, but with the same results. The sentence was reversed.†

These experiments did not convince Foderé, who thought that if the night were dark, and the persons within six, eight, or ten feet of each other, identification was possible; and the results arrived at by the French experimenters are certainly at variance with the opinions of persons accustomed to the use of fire-arms, as well as with our own experiments. We repeatedly recognised the face of a person with which we were familiar by the discharge, in the dark, of a gun close at hand. It may also be reasonably contended, that under the influence of strong excitement the perceptions are uncommonly acute, as the actions are unusually rapid. A person exposed to danger might therefore have a quicker and more distinct perception than an experimenter. The question, then, is one which admits of satisfactory solution only by collecting cases of this class.

The following case occurred in England in 1799. A man named Haines was indicted for shooting at Edwards, Jones, and Dowson, Bow Street officers, on the highway. Edwards deposed that, in

* Montgomery: 'Cyclopædia of Pract. Med.,' art. Identity.

† Quoted by Beck from the 'Causes Célèbres.'

consequence of several robberies near Hounslow, he, with Jones and Dowson, set off in a post-chaise one evening in November, and were attacked near Bedfont by two persons on horseback, one of whom stationed himself at the head of the horses, and the other at the door of the chaise. The night was dark; but from the flash of the pistols he could distinctly see that the man at the chaise-door rode a dark-brown horse, between thirteen and fourteen hands high, of a very remarkable shape, having a square head, and very thick shoulders, and altogether such that he could pick it out of fifty horses: he had since recognized it. He also perceived by the same flash of light that the man had on a rough shag-brown greatcoat.*

A few other cases of the same class have occurred in England; and the reader will find a French case in confirmation in the Introduction to Foderé's 'Treatise' (note, p. 28).

II. IDENTITY OF THE DEAD.

In cases of death by accident or violence, and in cases of exhumation, the medical man may be required to identify the dead. He may be called upon to assist in identifying the entire body; to reconstruct one which has been cut to pieces, and the parts scattered; or to examine a skeleton, or parts of it, in order to determine the sex, age, and probable stature of the person to whom it belongs.

By a careful examination of the body we may ascertain the sex, form some judgment of the age, and even guess at the trade or occupation by the muscular development, the skin of the palms of the hands and the nails (indicating hard work, or the reverse), and the presence of tattooing so common in soldiers, sailors, and the idler classes, so rare in other persons. Stains on the hands or clothes also sometimes help us to determine the employment. (See this subject treated in detail in the *Manual* of Briand and Chaudé, 7th edition, p. 558.)

Many successful cases of identification are on record, of which the following are examples:—

Dupuytren identified a murdered man chiefly by a malformation of the hip-joint; and by a like deformity MM. Laurent, Noble, and Vitry identified a corpse buried in a cellar at Versailles three years. The body of Maria Martin was identified eleven months after her death by the absence of certain teeth from the upper and lower jaw, and by signs of inflammation, with extensive adhesions of the pleura, answering to an attack of inflammation of

* Montgomery: 'Cyclop. of Pract. Med.,' art. Identity.

the chest, from which she was proved to have suffered shortly before her mysterious disappearance. A doubtful case, tried at Edinburgh, was decided by a dentist, who produced a cast of the gums taken before death. The scanty remains of the body of the Marchioness of Salisbury, discovered in the ruins of Hatfield House, were also identified by the jaw-bone having gold appendages for artificial teeth; and the identification of the body of Dr. Parkman (*see* p. 24) was greatly assisted by the very peculiar formation of the jaw, and the correspondence of a part of it with a cast taken by a dentist.

In some remarkable instances the work of identification has consisted in discovering, after a considerable period of interment, the bodies of celebrated personages about whose real burial-place a doubt had been raised. In other instances the body has been completely identified by the close resemblance of the face of the corpse to extant pictures, busts, or coins. The identification of the remains of Henry IV. in Canterbury Cathedral, after the lapse of nearly four centuries and a half,* is an example of the first class of cases; the identification of the remains of Charles I., after 165 years, of the second class.† The remains of Charles I. were completely identified by the striking resemblance of the countenance, notwithstanding its disfigurement, to his portrait on coins, busts, and paintings, and by the fact that the fourth cervical vertebra was found smoothly divided transversely. As this case is an excellent illustration of the condition, after 165 years, of a body suddenly deprived of life, embalmed and interred in lead, the following brief particulars are added:—On removing part of the lead coffin an inner coffin of wood much decayed was exposed, and within this the body wrapped in cere-cloth, into the folds of which an unctuous matter, mixed with resin, had been poured, so as to exclude the air. The coffin was quite full, and on removing the covering from the face, the skin was found dark and discoloured, the forehead and temples well preserved, the cartilage of the nose gone, the characteristic pointed beard perfect, the left ear entire, and the left eye open and full, though it vanished on exposure. The head was found loose, and was easily taken out and held to view. It was heavy, wet with a liquid which gave to writing-paper and linen a greenish-red tinge, the textures of the neck were solid, and the back part of the scalp was perfect and of a remarkably fresh appearance. The hair of the head was of a beautiful dark brown, that of the beard of a

* See Felix Summerly's 'Handbook for Canterbury.'

† 'An account of the opening of the tomb of Charles I.' in Sir Henry Halford's 'Essays and Orations.'

redder tint. The divided muscles of the neck had retracted considerably, and the smooth surface of the divided fourth vertebra was visible.

Fig. 1.

A reduced copy of the engraving which accompanies the description is annexed.

In the same vault in which Charles I. was interred, Henry VIII. had been deposited. The leaden coffin, which had been enclosed in a thick elm case, appeared to have been beaten in so as to leave an opening large enough to expose a mere skeleton of the king, with some beard upon the chin. The body of the king had then been interred 266 years.

To the preservation of the bones it is impossible to set any limit of time. The bones of King Dagobert, disinterred from the Church of St. Denis, after 1200 years, others from Pompeii after 1800, and others as parts of Egyptian mummies full 2000 years old, attest their permanence. There is, therefore, no medico-legal case in which they would not be found in a state fit for examination.

The cases of mistaken identity in the living have their parallels in the dead, as the following case will show:

A resurrection-man was tried for raising the body of a young woman from the churchyard of Stirling, nine weeks after death. It was identified by all the relations, not only by the features, but by the left leg being shorter than the right. The jury was convinced that the *libel was proven*, and gave a verdict accordingly. "Now I am certain that this was not the body of the woman who was taken from the churchyard of Stirling, but one that, at least six weeks after the time libelled, was buried in the churchyard of Falkirk, from which she was taken by this man, who also took the other for which he was tried; she also was lame of the left leg: thus, though guilty of the offence laid to his charge, he was found guilty by a mistake of the *corpus delicti*."—(Dunlop, note to Beck's 'Medical Jurisprudence.')

Cases illustrative of the possibility of dead persons being mistaken for living ones, not merely by acquaintances and friends,

but by parents and near relations, are recorded by Smith, and by Dr. Cummin, in his lectures. ('Medical Gazette,' vol. xix.)

Calculation of the Stature from the length of a part of the body.—M. Sue attempted a century ago to furnish data for calculating the stature from the length of the extremities.* He measured subjects of medium height, chosen as well proportioned. The following table presents his measurements reduced to English feet, inches, and lines. The first three lines of the table show the results of only one measurement; the last two lines are founded on averages:—

Age.	Body.			Trunk.			Upper Extremity.			Lower Extremity.		
	Ft.	In.	Lin.	Ft.	In.	Lin.	Ft.	In.	Lin.	Ft.	In.	Lin.
1 year . .	2	0	0	1	2	5	0	9	7	0	9	7
3 years . .	2	11	3	1	8	4	1	3	0	1	3	0
10 years . .	3	11	0	2	1	7	1	8	4	1	9	11
14 years . .	4	10	8	2	5	11	2	4	1	2	4	10
20-25 years .	5	8	2	2	10	1	2	8	0	2	10	1

M. Sue states, that towards the 20th, and from that to the 25th year, the upper border of the symphysis pubis forms the exact centre of the body, and that this continues constant for more advanced ages, except that in old age the spine becomes curved. Before the adult age, the centre of the body varies according to the age.

These measurements, repeated by Orfila, both for the subject and for the skeleton,† showed that the statements of M. Sue must be received with caution. Thus of 44 males (with 4 exceptions adults), only 7 had the length from the vertex to the pubes exactly equal to the length from the pubes to the sole of the foot; whilst in 23 instances, the former measurement exceeded the latter; and in 14 fell short of it. The greatest difference on either side was $2\frac{1}{3}$ inches English. Again, out of 7 females, there was not one in whom the above measurements were equal; the upper half of the body was longest in 6, shortest in one. The males on an average were longer from the vertex to the pubes by more than $\frac{1}{3}$ inch, the females by $1\frac{1}{6}$ inch. On examining the tables more closely, and bringing together the instances in which the length from the vertex to the pubes happens

* 'Sur les Proportions du Squelette de l'Homme.' Mémoires présentés à l'Académie Royale des Sciences, tom. ii. 1755.

† 'Traité de Médecine Légale,' tom. i. p. 105.

to be the same, we have found a considerable difference in the length from the pubes to the sole of the foot. Thus of fifteen males measuring 2 feet 9 or 2 feet 9½ inches from the vertex to the pubes, one measured as little as 2 feet 7 inches from the pubes to the sole of the foot, while another measured 2 feet 11½—a difference of 4½ inches. Again, of five females, in whom the upper measurement was 2 feet 6¾ to 2 feet 7 inches, one measured little more than 2 feet 4, the other little less than 2 feet 8—a difference of nearly 4 inches.

So that in making use of Orfila's measurements, we might be in error to the extent of from 4 to 4½ inches. Orfila's table of measurements of the skeleton exhibits deviations still more remarkable; for in one instance in which the upper part of the body measures 3 feet 1½, the lower part measures only 2 feet 8, being a difference of 5½ inches; and, in another instance, in which the upper measurement was 2 feet 5½, the lower measurement was 2 feet 11½, being a difference in the opposite direction of 6 inches.

It follows, then, that M. Sue's facts are too few, and his statements too general, to admit of practical application; and that in using the more numerous and exact measurements of Orfila, to determine the stature of the body, we might commit very serious errors.

Orfila's measurements of the cylindrical bones, from which he proposes to calculate the stature of the skeleton and of the living body, also yield, as the subjoined tables show, very unsatisfactory results:—

Stature of the Skeleton calculated from the Length of the Cylindrical Bones.—(Orfila's second table.)

LENGTH OF A BONE.				STATURE.							
				Max.			Min.			Difference.	
	Ft.	In.	Lin.	Ft.	In.	Lin.	Ft.	In.	Lin.	In.	Lin.
Humerus (6 obs.)	1	1	0	6	1	3	5	9	9	3	6
Ulna 7 ,,	0	10	8	6	1	3	5	5	0	8	3
Femur 7 ,,	1	6	1	6	0	0	5	7	0	5	0
Tibia 7 ,,	1	3	0	5	10	6	5	5	0	5	6

We see by this table that, for the same length of cylindrical bone, we may have a range of stature of from three and a half to no less than eight and a quarter inches.

Stature of the Body, calculated from the same data. (Orfila's first table.)

LENGTH OF BONE.		STATURE.		
	Ft. In. Lin.	Max Ft. In. Lin.	Min. Ft. In. Lin.	Difference. In. Lin.
Humerus (19 obs.)	1 2 6	5 8 1	5 4 6	3 7
Ulna 14 ,,	0 10 8	5 10 10	5 5 8	5 2
Femur 12 ,,	1 5 9	5 9 8	5 4 6	5 2
Tibia 11 ,,	1 2 5	5 9 8	5 4 6	5 2

It appears, then, that for the same length of cylindrical bone, we may have a variation in the stature of the body of from more than three and a half to upwards of five inches.

This minute analysis of Orfila's tables has been rendered necessary by the undue importance which he himself attached to them; for he says, "we are certain that it will be possible in the greater number of cases, on consulting these tables, and on having regard especially to the lengths of the femur and humerus, to arrive sufficiently near the truth." This excess of confidence arose from his not having really examined his own figures,—an examination the more desirable, as his high authority has led to the use of his tables for practical purposes. Thus, Dr. Henri Bayard, in three instances, in which the only parts of the body left were the bones, applied Orfila's data; in two unsuccessfully, but, in the third, with a success which is obviously attributable to a happy coincidence.

The following table shows the average measurements in English feet, inches, and lines, obtained from 44 male and 7 female subjects.

	Stature.	Vertex to Pubes.	Pubes to Foot.	Upper Extremity from Acromion.	Femur.	Tibia.	Fibula.	Humerus.	Radius.	Ulna.
Male .	5 6 6	2 9 6	2 9 0	2 5 6	1 5 8	1 2 7	1 2 2	1 0 5	0 9 5	0 10 2
Female	5 1 0	2 7 1	2 5 11	2 2 8	1 4 6	1 1 9	1 1 5	0 11 7	0 8 8	0 9 9

It is obvious from the foregoing statements that the determination of the stature from portions of the body or skeleton is much less easy than the French authorities have represented it to be.

AGE.

The law defines with much minuteness the privileges, immunities, and responsibilities which belong to the several periods of life. It rarely happens, however, that the medical man is required to give evidence on this point; and the occasions on which his opinion may be required will become less numerous as our system of registration of births comes into more complete operation.

It is chiefly as a preliminary means of identification that the question of age is important, and, like the general question of identity, it divides itself into two parts. 1, *The Age of the Living;* and 2, *The Age of the Dead.*

I. AGE OF THE LIVING.

Many attempts have been made to give this subject an air of importance, and much learning has been expended upon it. The arbitrary division of human life into septennial and decennial periods, the equally arbitrary assumption of certain ages as epochs of unusual importance and danger (the climacterics), and the laboured descriptions of bodily and mental changes—all these are wanting in the precision necessary for medico-legal purposes; and the same remark is true of the calculations of Quetelet, based on the ascertained stature and weight of the body at different ages.

The same objection applies to the position of the centre of the body as a test of age. It may be stated, in general terms, that at birth it is at the navel; in the adult, at the pubes; for intermediate ages, at intermediate points, nearer to the navel in the infant, and to the pubes in those approaching adult age; and that in women, in consequence of the comparative shortness of the lower extremities, but especially the thigh bones, the centre of the body is above the pubes.

The facts collected in illustration of the period of puberty in the two sexes, and of change of life in women, also show the little dependence to be placed on these occurrences as indications of age. The extremes are so far apart as to render it unsafe to apply the average results to individual cases.

During earlier ages we have more precise, though still very imperfect, means of fixing the age in the successive appearance of the teeth both of the first and second dentition.

The first set or milk-teeth appear in the following order:—

Central incisors	5— 7	months.
Lateral incisors	6— 9	,,
First molars	8—15	,,
Canine teeth	15—18	,,
Second molars	18—24	,,

The milk-teeth, then, appear at different times in different children. Some are born with the incisors above the gums; others have no teeth till the end of the second year; others, again, live several years without a single visible tooth.

The order and probable time of appearance of the permanent set of teeth, with the number of teeth existing at each age, is shown in the annexed table.

AGE.	INCISORS.		Cuspids.	BICUSPIDS.		MOLARS.		
	Central.	Lateral.		Anter.	Poster.	Anter.	Second.	Poster.
7 years.	...	...	...	...	...	4	...	...
8 years.	4	...	...	...	...	4	...	...
9 years.	4	4	...	...	...	4	...	...
10 years.	4	4	...	4	...	4	...	...
11 years.	4	4	...	4	4	4	...	...
12—12½.	4	4	4	4	4	4	...	...
12½—14.	4	4	4	4	4	4	4	...
18 —25.	4	4	4	4	4	4	4	4

As it was thought that this table might be employed as a standard of comparison in determining the age of children, especially of those employed in factories, Mr. Saunders* selected the two periods of 9 and 13 years, observed the number of teeth existing at those periods in many hundred children, and obtained the following results:—

Of 457 boys 9 *years of age*, 219, or nearly one-half, had the number of teeth stated in the foregoing table; namely, 4 central incisors, 4 lateral incisors, and 4 anterior molars. Of 251 girls, of the same age, 168, or considerably more than one-half, had the same number. Taking the two sexes together, 387 out of 708 had the full complement of teeth. The remainder in both sexes consisted of children who, in place of the full number of 4 of each kind, had a smaller number of one or the other. Thus in a large proportion of the children, one, two, or three out of the four lateral incisors were wanting, and so of the other teeth. In 52 cases only the lateral incisors were entirely wanting.

If, then, in each column of the table, opposite the age of 9 years, we substitute for the number 4, the numbers 1, 2, 3, or 4, and assert that wherever any of those numbers of teeth are found to exist, there we may assume that the child is in its

* 'The Teeth a Test of Age.' By Edwin Saunders.

9th year, our assertion will be borne out in 656 out of 708 cases, or in about 13 in every 14. In the remainder, 52 in number, a child of eight years might, by using the foregoing table, be mistaken for one of nine years.

The results of the inquiry respecting children who had attained the age of 13, were as follows:—

Rather less than half the boys, and more than half the girls, and as nearly as possible half of the two sexes taken together, had the full complement of teeth entered in the table as belonging to children of $12\frac{1}{2}$ to 14 years of age: by far the majority of both sexes had one or more of the several orders of teeth: and in 11 instances only were some or other of the teeth wholly wanting. In three cases a child of 13 might have been mistaken for one of 12 to $12\frac{1}{2}$; in one instance for one of 11, and in one instance for one of 10. In a vast majority of instances, however, we should be justified in stating that a child having one or more of the several teeth indicated in the table opposite the period of $12\frac{1}{2}$ to 14 years had completed its 13th year.*

The permanent set of teeth is not complete till the *dentes sapientiæ* make their appearance. This usually happens from the 18th to the 25th year, but it sometimes takes place much later; and one case is recorded by Dr. Hamilton of a man of 80 who died from the irritation produced by cutting a wisdom-tooth.

Among the signs of age on which some stress has been laid is the white line round the margin of the cornea, known as the *arcus senilis.* As the cause of the arcus has been shown to be a deposit of oil-globules in the cornea, which may take place from causes other than advancing age; as Mr. Canton reports cases from his own observation, or on the authority of others, in which this appearance has been present at 42, 34, 33, and even 28 years of age; and as we have ourselves seen this circle completely formed at 42 and 39, and absent at 79 and 85, it is obvious that this appearance must be rejected as a test of age.†

All other indications of age in the Living, such as grayness or baldness of the hair, and loss of teeth, are deceptive. Cases of premature old age, of unusual vigour at advanced periods of life, and of restoration in the aged of some of the structures and functions proper to an earlier period of life (*e.g.* the cutting of teeth and the growth of coloured hair; the secretion of milk, and the persistence or return of the menstrual discharge), will some-

* The results here stated in general terms were given in the first edition of this work in a tabular form.

† On the Arcus senilis, or fatty degeneration of the Cornea. By Edwin Canton, F.R.C.S.: 'Lancet,' May 11, 1850, and January 11, 1851.

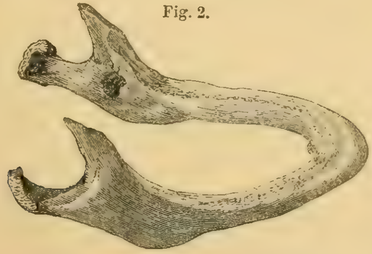
times prevent us from even guessing at the age with any success. On the other hand, the early occurrence of the marks of puberty in both sexes, and the premature or very late appearance of the menses in the female, create difficulties in rightly estimating the age at earlier periods of life.

II. AGE OF THE DEAD.

In examining the bodies of persons recently dead, we have the same means of estimating the age as in the living. Sometimes, too, we may learn something from the dissection of the body. Bony deposits in the heart and arteries, for instance, afford a strong probability that the subject had reached a mature if not an advanced period of life.

The state of the bones also furnishes some clue to age, both in the young and old. The imperfect ossification of the bones, and of their processes and epiphyses, and the condition of the cartilages of the larynx and ribs, render us some assistance in infancy, childhood, and youth.* At the other extreme of life, marked changes also take place. The internal cavities of the bones increase, from the absorption of osseous matter, and the bones become lighter. The bones of the head are solidly united, but, on account of the absorption of their diploe, become thin. The spinal column is curved. The cartilages of the larynx and ribs are completely ossified. The osseous tissue generally is more dense, dry, and fragile, and abounds in earthy materials. In very old persons the appearance of the lower jaw, as shown in the annexed engraving, is highly characteristic. The body is very shallow, owing to the absorption of the alveolar border, and the angle is obtuse as in childhood.

Fig. 2.



* The reader will find minute details of the progress of ossification in its relation to age in Orfila's treatise (vol. i. p. 106); in Béclard's 'Anatomie Générale,' p. 495; and at p. 31 of the first edition of this work.

SEX.

This subject, like the foregoing, divides itself into two parts. 1, *The means of ascertaining the Sex of the Living;* and 2, *The means of determining the Sex of the Dead.*

I. SEX OF THE LIVING—DOUBTFUL SEX.

The question of sex may be raised in reference both to infants and adults. In the case of a new-born child the issue of parents possessed of real or landed property, the right of succession, and should it die, the disposal of the property, must depend on the sex. If a wife, being tenant in tail-male, is delivered of a son born alive, the husband's right is secured; but the property passes from him if she gives birth to a daughter. This form of succession is termed *tenancy by the curtesy.*

It may be necessary also not merely to ascertain the sex, where that can be done, but in doubtful cases, to determine which sex predominates; for it appears, on the authority of Coke upon Littleton, that "an hermaphrodite, which is also called Androgynous, shall be heire, either as male or female, according to that kind of the sexe which doth prevail, and accordingly it ought to be baptized."

The question of sex may also arise at a later period, as in the case quoted by Beck of a young nobleman of doubtful sex, whose parents consulted a medical man whether the education should be that of male or female.

There are three conditions of the organs of generation which may present difficulties to the medical examiner.

1. The male organs may resemble the female.
2. The female organs may resemble the male.
3. The organs of the two sexes may be blended.

1. The male organs may resemble the female. (Androgyni.) The most common malformation of this sort consists of a small, imperfect, and imperforate penis, a short canal beneath it, and a cleft scrotum, these parts bearing respectively some resemblance to the clitoris, vagina, and labia of the female. Each section of the scrotum may contain a testicle, but the testes, one or both, may be lodged behind the external ring. The short canal, or *cul de sac*, which replaces the urethra and opens at the base of the penis, or in the perineum, near the anus, is found to communicate with the bladder. It is often enlarged at its commencement, so as to resemble the vagina; and has been even made to discharge its sexual function. From the position of the opening of the

urethra beneath the imperforate penis, these persons are called *hypospadians*.

The existence of the testicles in the folds resembling the labia, or in the groin; the communication of the opening beneath the imperforate penis, or in the perineum, with the bladder; the absence of any organ corresponding to the uterus; and, in the adult, the absence of menstruation,—enable us at once to determine the sex. In most of these cases the build of the body, the muscular development, the tone of voice, the tastes and habits, are more those of a man than of a woman. Nevertheless there are cases in which an enlargement of the breasts, coupled with a preference for the society of the male, might mislead in the absence of a careful examination of the organs of generation. In other instances the sexual passion is absent. Several cases answering to this description are on record; and there are preparations illustrating these malformations in most of our museums. A case by Mr. W. Loney ('Lancet,' May 7, 1856) is an excellent illustration of this class of malformations. Jane W——, a lunatic, twenty-eight years of age, was admitted into the Macclesfield workhouse. She excited suspicion by her unwillingness to be washed, and on being examined, she was found to have a penis two inches long, and the same in circumference, placed on the pubes, just above and between the external labia; with a well-defined prepuce, which could be moved at pleasure, causing a slight erection. Just below this was an opening so small as to admit the little finger with difficulty; and a ligamentous band could be felt at about three inches distance from its mouth. The urethra could not be seen, but a catheter was passed into the bladder through this opening. The penis was imperforate. The hair of the head was short and curly, like a man's; the limbs very muscular and hairy; and the voice exceedingly rough and masculine. The mammæ were entirely absent, and there was more hair than usual about the pubes. She had never menstruated. Her taste was so depraved that she would eat old poultices with great delight. She was strong and healthy, and annoyed the young women in the same ward by the display of her amatory propensities.

Sometimes the penis, well or ill-formed, is confined to the scrotum by a peculiar formation of the integuments. This malformation, with the other deviations from the normal structure just described, occurred in two cases, one a negro, the other a European, of which Cheselden gives engravings; and in the case of a child baptized and brought up as a girl, Mr. Brand by a slight incision liberated the restricted parts, and proved

to the parents that they had mistaken the sex of their child.

Another malformation belonging to this division, and which might possibly give rise to doubt as to the sex, consists in a deficiency of the anterior wall of the urinary bladder, and of the corresponding part of the abdominal walls, their place being occupied by an irregular red and sensitive mass, with the ureters opening upon it. The penis is short, imperfect, and imperforate. The vesiculæ seminales open near the red and sensitive surface just described, or in a small tubercle at the root of the penis. The testicles are generally well formed, sometimes contained in the scrotum, sometimes to be felt in the groin, or they have not descended. The sexual appetite in some of these persons is weak; in others strong; in others altogether wanting. Those who have this malformation are called *Epispadians*.

2. The female organs may resemble the male. (Androgynæ.) An enlarged clitoris is the most common malformation belonging to this class. None of the recorded cases, though exciting great interest, presented real difficulty. The absence of testicles from the labia, the presence of a vagina and uterus, the occurrence of menstruation, these singly or combined, render the distinction easy.*

A prolapsus uteri has more than once given rise to a question of sex. Sir Everard Home mentions the case of a Frenchwoman suffering from a prolapsus evident on inspection, who laid claim to the male sex, and was shown as a curiosity. And Mahon relates the case of one Margaret Malaure, exhibited at Paris in 1693, dressed as a man, and alleging that she possessed and could use the organs of both sexes. Several physicians and surgeons certified that she was an hermaphrodite; but Saviard, an eminent surgeon, being incredulous, examined her in the presence of his brother practitioners, and found a prolapsus uteri, which he reduced.

3. The organs of the two sexes may be blended.

Many cases of this imperfect approach to the true hermaphrodite are on record. In some an ovary has been found on the left side, and a testis on the right; in others the position of these organs has been reversed; and in a third class of cases the external organs have approximated closely to the female type, and the internal to the male, or the reverse.†

* See the cases illustrative of this malformation detailed at length in 'Cyc. of Anatomy and Physiology,' art. Hermaphroditism.

† See the case of Durrje or Derrier in Cummin's Lectures, 'Med. Gaz.,' vol. xix.: and for cases of the last-named malformation, occurring both in man

But no case of real hermaphroditism, in other words, the organs of the two sexes in a state of perfect development in the same person, is on record.

In examining cases of doubtful sex, the following points should be attended to:—The size of the organ corresponding to the penis or clitoris, and whether it is perforate or imperforate; the form and mode of attachment of the prepuce; the presence or absence of parts corresponding to the nymphæ; the presence or absence of testicles. The openings that exist must be carefully examined with a sound, to ascertain whether they communicate with the bladder or uterus, or are merely *culs de sac;* and inquiry should be made respecting the existence of the menstrual discharge, or of vicarious discharges. The general conformation and appearance of the body should also be observed, including the growth of the beard,* and of hair on different parts of the body; the formation of the shoulders and hips; the development of the breasts; the fulness of the thighs; the tone of the voice; and the feeling and conduct towards either sex.

II. SEX OF THE DEAD.

When the entire body is submitted to our inspection, we shall find no difficulty in determining the sex, except in those rare instances in which the characters of the two sexes are blended. In some of these cases the sex which could not be determined during life, has been ascertained by dissection.

But when the question of sex is raised after death, it is generally in reference to the skeleton, or some part of the osseous system, in which the following differences are observable:—

The *bones* of the female are lighter, more cellular, smoother, and less curved, than those of the male: the processes less marked, and the joints smaller. The *skull* of the female is smaller, more ovoid, more bulging at the sides, and longer behind the foramen magnum; the face more oval, the frontal sinuses less strongly marked, the nostrils more delicate, the jaws and teeth smaller, and the chin less prominent. The *chest* of the female is deeper than that of the male; the sternum shorter and more convex; the ensiform cartilage thinner, and ossified later in life; the ribs smaller, and the cartilages longer. The *vertebral column* is

and animals, the very complete and learned paper on Hermaphroditism in the 'Cyclopædia of Anatomy and Physiology.'

* The curious case given by Dr. Chowne of an otherwise well-developed female with copious beard and whiskers, cautions us not to attach too much importance to any single sign detailed in the text. For the case itself, and a learned history of similar instances, see 'Lancet,' 1852, vol. i. p. 421.

longer, and the bodies of the vertebræ are deeper in the female than in the male. The *pelvis*, however, presents the most striking contrast. The ilia are more expanded and horizontal in the female; the sacrum more concave; the pubes more shallow; the angle formed by the descending rami more obtuse; the pubic arch wider; the tuberosities of the ischia more largely separated; the foramen ovale larger, more triangular, and more oblique; the acetabula wider apart; the entire pelvis more shallow, but larger in its outlets than in the male. These differences are shown in the annexed engravings, in which A represents the male, and B the female pelvis.

The difference between the male and female skeleton is less strongly marked before the age of puberty.

Fig. 3.

A well-formed adult female pelvis measures at the brim about $4\frac{1}{2}$ inches from before to behind; about 5 inches from side to side; and about $5\frac{1}{8}$ inches obliquely. At the outlet it measures 4 inches from before to behind, and the same from side to side.

This group of subjects—identity, age, and sex—may be advantageously brought to a close by two cases, the one French the other American, in which the question of identity was raised and the diagnostic marks of age, and (in the first case) of sex also, were practically applied.

1. In the year 1821, a widow lady of the name of Houet, residing at Paris, disappeared; and Bastien, Robert, and Robert's wife, suspected of having made away with her, were tried before the Court of Assize; but for want of evidence, were set at liberty. But in consequence of information subsequently obtained touching a body said to have been buried for about eleven years in a particular garden, the remains were so completely

identified, and the manner of the death so clearly shown, that the prisoners were convicted and punished.

The exhumation was conducted under the direction of M. Boys de Loury. After excavating different parts of the garden a workman hit upon a hollowed spot, which, on being carefully opened, was found to contain the remains of a human body, reduced almost to a skeleton. A drawing was made of the parts *in situ*. The figure lay on the left side, with the head bent on the neck, the vertebral column curved, the right fore-arm raised, so that the hand nearly touched the face. The pelvis was turned obliquely upwards. The thigh-bones were raised, and the legs crossed beneath them. The prevailing colour of the remains was yellowish-brown, but the parts in contact with some of the long bones were of a deep-red tint.

The bones were small and delicate, those of the extremities not curved by muscular motion, and the marks of the insertion of the muscles few and faint. Among the bones of the left hand were found a small gold ring, carved in *facettes;* and several small well-formed finger-nails. The skull was small, and oblong; the sutures well knit; the teeth white and well preserved; but three molars were wanting, and one of the incisors was carious. Some light-coloured hair was found, having gray hairs mixed with it. The ossa innominata were largely spread out; the cavity of the pelvis not deep; the anterior part of the sacrum concave; the sub-pubic holes triangular; the cotyloid cavities wide asunder; and the upper opening of the pelvis had the diameters usual in well-shaped females. It was therefore justly inferred that this was the skeleton of a woman.

The state of the neck was very striking. The third, fourth, fifth, and sixth cervical vertebræ, and right clavicle, were held together by a blackish mass, surrounded by several twists of a small decayed cord. The inference, that the deceased had been strangled, was fully borne out by the circumstantial evidence.

Several elaborate documents were drawn up by the reporters; of the first of which the following is a *résumé:*—

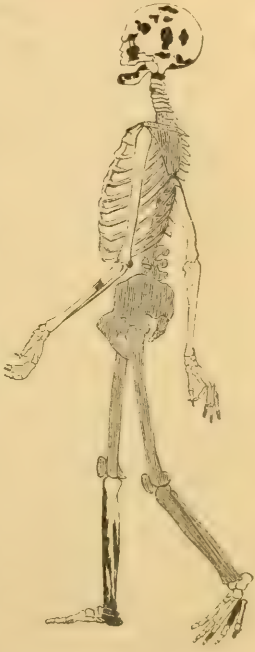
"1. That these bones are those of a *human* skeleton. 2. That the skeleton is that of a *female*. 3. That she had attained the *age* of from 60 to 70. 4. That her stature was about 4 feet 8 or 9 inches. 5. That her hair, which was a bright blond in youth, was mixed with gray at the time of her death. 6. That the hands were small. 7. That during life the bones had never suffered any injury. 8. That this woman died of strangulation, and that the act was, to all appearance, homicidal; and 9. That the body must have lain for several years in the earth."

The prisoners, who had been long suspected, were tried, condemned, and sentenced to forced labour for life.

2. Dr. George Parkman, of Boston, was last seen alive on the afternoon of Friday, Nov. 23rd, 1849, entering the Medical Institution in which Dr. John W. Webster was Lecturer on Chemistry; and it was proved that he went there by appointment to receive money which Dr. Webster had long owed him. Dr. Parkman was missed, and could not be found; but on the Friday following his disappearance, in consequence of the suspicions aroused against Dr. Webster, search was made in his laboratory and the places attached to it, which issued in the discovery, in the vault of a privy, of a pelvis, right thigh, and left leg, and some towels marked with Dr. Webster's initials, such as he was in the habit of using. There were also found in the furnace of the laboratory, mixed with cinders, many fragments of bone, blocks of mineral teeth, and a quantity of gold. A tea-chest was also found, which contained, embedded in tan, and covered with minerals, the entire trunk of a human body, the left thigh, a hunting-knife, and a piece of twine of the sort used in the laboratory. On the left side of the chest a penetrating wound was discovered; and to this the death was attributed. These portions of a human body being found in a medical college, it might be alleged that they were parts of a dissected subject; but this was shown not to be the case, for the vessels were free from all trace of the preservative fluid always employed in that college. They contained neither arsenic acid, nor chloride of zinc. It was further proved that the joints had been severed as by a man having some anatomical knowledge, and some practice in dissection. The first step in identification consisted in putting together the fragments of the body. These fitted accurately. The 3rd and 4th lumbar vertebræ coincided; "the right thigh, on being placed in apposition with the pelvic portion, the bones, muscles, and skin, corresponded perfectly;" so also with the left thigh and pelvis; and the left leg and thigh. The fragments, therefore, belonged to the same body; and it was shown that there were no duplicate members or bones. By putting the parts together, and measuring them, they were found to be 57½ inches long; and adding 3 inches for the length from the outer malleolus to the sole of the foot, and 10 inches, from the crown of the head to the base of the 6th cervical vertebra, the length was brought up to 70½ inches, the exact stature of Dr. Parkman, as proved by his passport. As to the age of the person to whom the body belonged, Dr. Stone stated that, judging from the skin, hair, and general appearance, the body belonged to a person from

50 to 60 years of age, and that the amount of ossification of the arteries would indicate that he was nearly or quite 60 years old. Dr. Parkman was about 60. The question of sex was not raised, as the parts of generation were found attached to the pelvis. 35 fragments of bone were found, and among these there were 3, which when put together, made up the greater part of the right half of the lower jaw, and the portion thus rebuilt enabled Dr. Wyman to ascertain that the teeth from the coronoid process to the first molar, or bicuspid, were wanting. To obviate this defect, a dentist had been applied to, not long before Dr. Parkman's death, to supply him with mineral teeth. These were found with the *débris* of the bones, in the furnace; and the cast the dentist had taken was found to fit, with great accuracy, the very peculiarly shaped jaw of Dr. Parkman.

Fig. 4.



Thus the identification was complete; and, after a long and patient investigation, Dr. Webster was found guilty, and at length confessed the crime. He first struck Dr. Parkman on the head with a heavy stick, and then stabbed him in the chest.

This short account is taken from a full report of the trial published at the time. Dr. Wyman exhibited at the trial a drawing of a skeleton with the bones that were found tinted yellow. In the annexed engraving, taken from p. 54 of the Report, these fragments are printed black. In cases of reconstruction of a mutilated body, the example set in this case might be advantageously followed.

CHAPTER II.

IMPOTENCE. RAPE. PREGNANCY. DELIVERY.

In the last chapter the subject of sex was examined as a means of identification; in this it is considered in relation to the generative function, and comprises the subjects at the head of the chapter.

IMPOTENCE.

The medical man may be required to ascertain whether or not a man is impotent, or incapable of sexual intercourse, in suits for divorce; in cases of contested legitimacy; and in accusations of rape. The question of incapacity for sexual intercourse is rarely raised in the case of females, and objection may perhaps be taken to the use of the term impotence in reference to women. But in order to avoid the needless multiplication of words, the meaning of the term is here extended so as to embrace both sexes.

Marriage being a contract entered into by two parties, presupposes, as do all other contracts, a free exercise of the will, and ability to fulfil its terms.

The first condition comes in question in marriages brought about by the exercise of undue influence on either party to the contract, and where it is alleged that the person so influenced was of weak or unsound intellect. (See Unsoundness of mind.)

In reference to the second condition—ability to fulfil the terms of the contract—we must premise that, in order to establish a ground for divorce, corporeal imbecility must have existed *before* the marriage, and be irremediable. The medical man may therefore be called upon to examine the person of the husband; but if he is not forthcoming, to examine the wife, in order to find confirmation of his alleged impotency. In a suit of nullity referred to by Mr. Chitty, a certificate was produced, twelve years after marriage, that the wife was *virgo intacta*, though *apta viro*, and that her health had suffered; and this, coupled with two confessions by the husband of his incapacity, with proof that he had not given in his answer, had removed into France, and had refused

to undergo examination, was held sufficient in the ecclesiastical court.

The subject of impotence will have to be considered under the two heads of—1. Impotence in the *Male*, and 2. Impotence in the *Female*.

I. IMPOTENCE IN THE MALE.

The causes of impotence may be distinguished as 1. *Physical*, 2. *Mental*.

1. The *Physical Causes of Impotence* are—*a*. Too tender or too advanced an Age. *b*. Malformation or defect of the penis. *c*. Defect or disease of the testicles. *d*. Constitutional disease or debility.

a. *Age*.—The earliest age recognised by law for the marriage contract is 14 in the male, and 12 in the female. "But the ecclesiastical courts look rather to the habit, strength, and constitution of the parties;" they inquire whether they be *habiles ad matrimonium*, and not how old they are; and the common law will hold infantile marriages, duly solemnized, valid, "when the parties on reaching the ages just stated do not demur to the contract."

The age of puberty, in both sexes, is subject to great variation. It is usual to recognise 14 years as its earliest advent in the male; but it may first show itself much later than this; and many examples of large development of the sexual organs in childhood are on record. Casper alleges that the power of coition begins earlier and ceases later than that of procreation; and, that in Germany the possession of the first-named power dates from about the thirteenth, and of the last from the fifteenth to the sixteenth, year. (Vol. iii. p. 258.) The signs of puberty are to be sought for in the general conformation of the body, the character of the voice, the growth of hair on the pubes, and the development of the organs of generation themselves. If all the genital organs are found to have the usual manly development, it may safely be inferred that complete sexual intercourse is possible.

But impotence may arise from old age as well as from immaturity: hence the question, At what age do the powers of procreation cease? which acquired an unusual interest in consequence of the celebrated Banbury Peerage Case.

This case was brought before the House of Lords, and decided in 1813. The principal argument urged against the claimant was, that the ancestor under whom he claimed was eighty years old when the child was born; but Sir Samuel Romilly, after

stating that the law of England admits of no age at which a man may not become a father, cited many medical authorities in its support. Thus Dr. Gregory, of Edinburgh, says—"Magna autem de his rebus differentia; decantantur enim exempla senum in castris Veneris strenue merentium, postquam centum annos compleverant; neque sane dubium, aut adeo rarum octogenarium patrem fieri." Haller likewise pronounces a man of ninety to be capable of procreating. Parr became a father in his one hundred and fortieth year. In short, the liberality of the law on this subject is excessive: for there is no age, from seven upwards, at which a man is denied the privilege of having children. Lord Erskine, following on the same side, cited the case of Sir Stephen Fox, who married at the age of seventy-seven, and had four children; the first born when the father was seventy-eight, the second and third twins in the following year; and the fourth when the father was eighty-one. The Attorney-General, Sir Vicary Gibbs, who opposed the claimant's title, evidently felt the weakness of the objection on the score of age, for he soon shifts his argument to more secure ground. He says: "Age may not be a proof of impotency, but it is evidence of it. The probability of the earl's begetting a child at eighty is very slight, and it is not increased by the appearance of another child two years later. Instances have been adduced of these extraordinary births, but none have been cited in which a man at eighty-two, having begotten a son, had concealed the birth of such son." It is clear, then, that no limit is fixed by law, or can be assigned by science, at which the power of procreation ceases. Old age, provided it be a robust old age, is obviously no impediment to procreation; and in the case of Lord Banbury, there is ample evidence of his having been capable of strong exercise till within a short period of his death.*

The finding of spermatozoa in the bodies of several men above 80 years of age, and of one æt. 96, lends confirmation to the facts founded on the fruitful marriages of old men.†

b. Malformation or defect of penis.—The experiments of Spallanzani and Rossi have shown that in animals complete sexual intercourse is not necessary to impregnation; but that the injection of semen by a syringe will suffice for that purpose, the animal being in heat: and John Hunter's ingenious expedient, recommended in a case of fistula in perineo, further proves that in the human subject the semen may be introduced in the same manner during the existence of the venereal orgasm with the same result. But the cases to be cited under the head of Preg-

* See Sir Harris Nicolas's treatise on the Law of Adulterine Bastardy.

† See Casper, vol. iii. p. 258, and p. 291 et seq.

nancy must be admitted to prove more than this. They show that a female may become pregnant in consequence of intercourse taking place in a state of unconsciousness, and accompanied by so little injury to the parts of generation as to attract no attention afterwards. Cases of pregnancy occurring in women with hymen intact may also be adduced in confirmation of the same view. So that it would seem that neither the introduction of the male organ nor the venereal orgasm, are necessary to impregnation. It follows, then, from these considerations, that small size or partial mutilation of the penis is not to be accounted a cause of impotence. Provided that what exists or remains of the organ is large enough to admit of introduction within the orifice of the vagina, and there be no impediment to the emission of semen, fruitful intercourse may take place. Thus, the removal of the glans penis; of the corpora cavernosa (as in a case quoted by Paris, from Piazzoni); of a very considerable portion of the organ (as in the case of a soldier quoted by Frank, in whom a large part of the penis was carried away by a musket-ball); did not occasion impotence. A still more extreme case is on record,* in which, in consequence of disease followed by amputation, there was only a very small protrusion of the organ on pressure, and yet the patient after the amputation became the father of two children. Amputation of the penis close to its root would in all probability cause impotence, though, for the reasons already assigned, fruitful intercourse is perhaps not altogether impossible.

The opposite malformation, excessive development, whether normal or a consequence of disease, can also scarcely be regarded as a cause of impotence; for though intercourse, in the ordinary sense of the term, were impossible, still impregnation might take place.

The same remark applies with equal force to a malformation of the penis, in which the urethra opens upon the organ itself, though not in the usual situation. Several such cases not resulting in impotence have been placed on record, and are the more conclusive, inasmuch as the malformation was transmitted from parent to child, and in one instance, reported by Frank, through three generations.

When the opening of the urethra, instead of being upon the penis, is in the perineum, fruitful sexual intercourse cannot take place unless the semen be artificially introduced into the vagina, as in Mr. Hunter's case of fistula in perineo. But, as in all such cases, it is possible that, either intentionally or accidentally, semen

* Mr. Hurd in 'London Med. and Surg. Journal,' vol. iv.

ejected from an opening remote from the penis might reach the vagina, and so cause impregnation, it would be unsafe to pronounce any person subject to such malformation to be incapable of fruitful sexual intercourse.

Hypospadians and *Epispadians* (pp. 19, 20), must be accounted incapable of complete sexual intercourse; and to become the parents of children must be assisted by artificial means;* or the discharged semen must in some unexpected manner be conveyed to the sexual organs of the female. The occurrence of cases of hereditary *hypospadia*, renders this event probable, while two cases at least of impregnation by hypospadians with the urethral orifice seated at the very root of the penis establish it beyond a doubt. Of these the case of the Hypospadian Johanna K., who became the father of a child similarly malformed, is the most striking.† Of *Epispadia* Casper says that he knows of no example of impregnation by a man so afflicted; while of the two states he says 'that of themselves' they 'form no reason for assuming an incapacity for procreation, so long as it cannot be proved' in any given case that it is impossible for any semen to enter the vaginal canal.

Congenital phymosis, and a confinement of the penis to the scrotum by a peculiar formation of the integuments, have been mentioned among the causes of impotence; but they admit of cure. Severe strictures, and extensive disease of the prostate gland, preventing the expulsion of the semen, and paralysis of the muscles of the penis, complete the list of the causes of impotence which have their seat in that organ.

c. Defect or Disease of the Testicles.—The excision of both testicles early in life occasions impotence; but when they are removed after puberty, the power of complete sexual intercourse may continue for a time, and a person so mutilated may even become a father, through the semen contained in the vesiculæ seminales. That sexual intercourse may take place for a considerable period after the removal of both testicles is proved by a case related by Sir Astley Cooper.‡ For about twelve months after the loss of the second testicle there were emissions in coitu; then sexual intercourse took place at distant intervals, but without emission; and, becoming less and less frequent, ceased at the end of ten years. Casper, on the authority of Peter Frank, tells us of four castrated soprano singers, who were banished from a small Italian town for their many sexual misdemeanours. The possibility of fruitful sexual intercourse taking place after cas-

* 'Ed. Med. and Surg. Journal,' vol. i. pp. 43, 132.

† Case by Traxel cited in Casper's Handbook, vol. iii. p. 250.

‡ 'Med. Chir. Rev.,' vol. xviii. p. 390.

tration, rests upon the discovery of apparently good semen in the vesiculæ seminales at a considerable interval after the removal of the testicles, as in a case cited by Otto; on the analogy of animals; and on at least one instance in the human subject. Sedillot cites a case on the authority of Boyer, in which, after the removal of both testicles, a man became a father.*

There has been much unnecessary discussion as to the possibility of a man having only one testicle being capable of fruitful intercourse. As impregnation cannot be supposed to depend on the quantity of the semen, we may safely affirm that one sound testicle is to the full as efficient as two. Men whose testicles are situate in the abdomen or in the inguinal canal are not only capable of sexual intercourse, but (as in the case of a criminal cited by Mahon) may earn a character for extreme licentiousness. The question of their power to impregnate will be considered presently.

Small size of the testicles is not sufficient ground for inferring impotence; for though there are cases on record in which it has coincided with a total absence of sexual desire, there is at least one well-authenticated instance in which both penis and testicles, being originally very small, there were sexual desires, erections with emissions, gradual increase in size, and fruitful intercourse.† The sufficiency of even a single small testicle is supposed to have been shown in the case of John Bury, which occurred in the reign of Elizabeth. His first wife, Willimet, alleged that he was impotent; and on inspection by two physicians he was found to have but one testicle the size of a small bean, while she was a virgin. On this and other circumstantial evidence, the ecclesiastical court annulled the marriage. But Bury took a second wife, by whom he had a son, and on his legitimacy being called in question, the common lawyers were unanimously of opinion that the ecclesiastical court had been misled, and pronounced the first marriage valid notwithstanding.‡

Of the *diseases* which affect the testicles, and cause impotence, the wasting which sometimes follows attacks of cynanche parotidea is the most important. Foderé witnessed several such cases in deserters condemned to labour on the canal at Arles, and Larrey in many soldiers of the army of Egypt. The testes lose their sensibility, become soft, and shrink to the size of a white French bean, and when both are affected, the beard grows thin, the intellect fails, and impotence results. Larrey could not trace the disease to

* Sedillot's 'Manual,' p. 17.

† Wilson: 'Lectures on the Urinary and Genital Organs,' p. 424.

‡ Hargrave's 'State Trials,' Appendix, vol. x. p. 24.

previous attacks of gonorrhœa, but attributed it to the use of the brandy of dates.

Elephantiasis and malignant diseases, such as scirrhus and medullary sarcoma, may also lead to the same result; but it would not be safe to pronounce in favour of impotence unless the entire structure of both testicles is affected.

Congenital scrotal hernia, long standing inguinal hernia, and tumours of large size involving the genital organs, or affecting the lower part of the abdomen or upper part of the thighs, may constitute mechanical impediments to sexual intercourse.

d. Constitutional disease or debility.—Diseases which occasion extreme debility may become causes of impotence (temporary or permanent), through the weakness to which they give rise. There must always, however, be great difficulty in determining the degree of debility or exhaustion from disease which entails impotence; and the same remark applies to age and natural decay.

But the diseases most likely to occasion impotence are those that affect the nervous centres, especially diseases of the spine, whether arising from internal cause, or from mechanical injury. Hemiplegia, from brain disease, and paraplegia, from disease or injury of the spinal cord, might be supposed to give rise to impotence; but that fruitful sexual intercourse may take place within a few weeks of a well-marked attack of hemiplegia is proved by the cases adduced on the occasion of the trial of Legge *v.* Edmonds. After partial recovery from paraplegia, also, the power of fruitful sexual intercourse does not appear to be lost.*

Case of Legge v. *Edmonds.*—The following is a careful summary of the facts of this case which are interesting in a medico-legal point of view. Mr. Legge, of Newent, married August 25, 1835, and died June 24, 1844. His wife was delivered of a daughter March 23, 1837, and again of a daughter October 30, 1844, being four months after the death of Mr. Legge. The first child attained the age of two years; the second survived four years. The legitimacy of the second child was called in question, partly on account of the state of health of Mr. Legge at the date of the conception, and partly in consequence of the alleged adultery of Mrs. Legge with the defendant, to whom she was subsequently married, and by whom she had children. Mr. Legge was an athletic man, and a free liver, occasionally drinking to excess, but not an habitual drunkard. On November 4th, 1843, when about thirty-five or thirty-six years of age, he had a well-marked apoplectic seizure, with loss of speech and hemiplegia

* See a case quoted from M. Brachet by Curling on 'Diseases of the Testes,' 2nd edit. p. 371.

of the right side, for which he was actively treated, and was so far recovered by November 27th, little more than three weeks from the date of the attack, as to cease to take medicine. The hired nurse left him at the end of five weeks. After the lapse of a week his speech was partially restored; he left his bed at the end of a fortnight; came down stairs as early as the end of the third week; by the end of the fourth week he was walking in the town, and drank tea out. At or about this period he was seen walking about by more than one witness. On December 7th (little more than a month after the attack), he went to Ledbury in a gig, driving himself part of the way, and signed his name at the bank, taking his hand out of a sling for the purpose. On December 27th he transacted business as usual, and wrote his name. He dined out near Newent before Christmas-day, and rode on horseback before the end of the year. On January 6th he visited Gloucester, and had transactions with several tradesmen. Before the end of January he supped there, and opened oysters, and on the 31st of the month attended a meeting, at which he took off his coat and challenged one of the company to fight. The most conclusive evidence was brought forward to prove that between the end of November, 1843, and the end of January, 1844, he had repeatedly transacted business and written his name, walked about without support, driven himself in a gig, ridden on horseback and leaped hurdles, gone out shooting, and killed game. It is also proved by the testimony of several witnesses that he had so far recovered before the end of January as to seem in perfect health. He had no new attack of illness till February 28th. His death in the June following was attributed to a general break up of the system, following dropsy, and disease of the liver.

From the foregoing summary, carefully compiled from the notes of Mr. Charles Jones, solicitor for the defence, it appears that there were no medical grounds for assuming incapacity for fruitful sexual intercourse at the end of January, the presumed date of the conception of the daughter whose legitimacy was contested. The adverse opinion of Drs. Taylor and Carpenter was based on other than medical considerations. The inquiry, commenced at Cheltenham, was afterwards continued in London, when the opinion previously expressed by Dr. Semple, Mr. Walsh, and the author was confirmed by Drs. F. Bird and Blundell, and the following facts were given in evidence:—1. E. K., æt. 58, when thirty-three years of age, had a well-marked attack of hemiplegia of the right side, which has left him lame, and with his speech slightly affected. He alleges that he had connection

with his wife within a week of his seizure, that his sexual powers have not been impaired, and that since the attack he has had three children always considered as his own. His wife gives three weeks as the extreme limit of time after the attack at which connection took place. The facts of this case were confirmed by Mr. Wetherfield, of Covent Garden, who added that he had known other cases of hemiplegic patients begetting children. 2. W. D., æt. 32, had an attack of hemiplegia of the right side when only twenty-six years of age, and a second attack when twenty-eight years old. Intercourse took place within a fortnight of the first attack; and there have been three children, of which the first was born in about eighteen months from the first seizure. Neither husband nor wife had any doubt that the children were their own.

In both these instances the recovery was less complete than that of Mr. Legge.*

Certain drugs, taken in single large doses, or used habitually in excess for considerable periods of time, such as opium, spirituous liquors, and tobacco, may give rise to impotence. Other substances of less power, such as camphor, coffee, and nitre, have been mentioned as causing impotence, but probably with insufficient reason.

Masturbation and early and excessive sexual indulgence are also acknowledged causes of impotence.

2. *Mental Causes.*—Excessive passion, timidity, apprehension, superstition, fear, aversion, and disgust, have been known to occasion impotence. With the exception of the last-named emotions—aversion and disgust—the remainder are transitory, and curable. That impotence with one female is not inconsistent with sexual ability in respect of others is proved by the case of John Bury, already referred to, as well as by that of the Earl of Essex, who admitted his inability to know the Countess, but denied his impotence as to other females.†

II. IMPOTENCE IN THE FEMALE.

The causes which prevent sexual intercourse in the female are, 1. *Narrowness of the vagina,* existing in all subjects before puberty, and in rare instances in the full-grown adult. In the latter, the defect may be remedied by emollients and cautious dila-

* The reader will find a full account of this case, differing in some material points from the preceding, and not comprising the cases of E. K. and W. D., in Taylor's 'Medical Jurisprudence,' sixth edition, p. 675.

† See Hargrave's 'State Trials,' vol. i. p. 315; or abstract by Beck, p. 54.

tation. 2. *Adhesion of the labia* from inflammation, and obliteration of the vagina from the same cause. 3. *Absence of the vagina*, accompanied in some cases by absence of the uterus. 4. *Imperforate hymen.* This often belongs to the class of curable causes. 5. *Tumours in the vagina*, such as polypi, scirrhous formations, prolapsus uteri, and prolapsus vesicæ. There are other causes which render sexual intercourse so difficult or painful as to deserve mention in connection with this subject. Of these the most important are—Unusual shortness of the vagina; inflammatory or malignant diseases of the vagina or uterus; extreme sensibility; a fistulous communication between the vagina and rectum, and internal piles. Of these some are obviously curable, others admit of no relief.

Sterility.—This may occur both in women and in men. In *women* some physical causes of sterility, such as absence of the uterus, closure of the neck, or of the Fallopian tubes, may escape detection during life. There are also curable causes of sterility, such as profuse discharges, menorrhagia and leucorrhœa, and alterations in the secretions of the vagina and uterus;* as well as causes little understood, but proved to exist by the fact that women sterile with one husband have become fruitful with another. Promiscuous intercourse, another acknowledged cause, is of a temporary nature, as is shown by the fruitfulness of married convicts who had been previously prostitutes.

Sterility in men is more interesting in a physiological than in a medico-legal point of view. It is certainly present in many men who are capable of complete sexual intercourse, and in others in whom there is complete mechanical intercourse without emission. Mr. Curling recognises three causes of male sterility:—malposition of the testicles, obstructions in the excretory ducts of the testicles, and impediments to the escape of the seminal fluid. The second of these causes may be brought about by double 'epididymitis' following gonorrhœa, and by scrofulous and malignant degeneration affecting both sides; also by congenital absence of the 'vasa deferentia.' The third cause may be brought about by stricture of the urethra, causing the semen to regurgitate into the bladder; also by other diseases giving rise to like impediments. The first of the three causes is the most interesting, for it appears to entail sterility without causing impotence. Mr. Curling gives a table containing nine cases (four of his own observing), in 2 of which both testicles were in the abdomen, in 2 one or other was there, in 2 both in the groin, the

† M. Donné has shown that these secretions, in females apparently in good health, are sometimes such as instantly to destroy the spermatozoa.

others being mixed cases; and in all these cases there was sterility, and the semen, on examination, was found destitute of spermatozoa. On the other hand, in three cases of non-descent of both testicles, by Mr. Poland, Mr. Cock, and Mr. Durham, the men were married and the reputed fathers of children. Two of them had married twice, and one had children by both wives. Mr. Curling, relying on the ascertained sterility of many of these 'cryptorchids,' coupled with the absence of spermatozoa, and attaching due importance to analogous observations on animals, is disposed to call in question the claims to paternity in these cases. But as, in order to do so, it would be necessary to suppose the most improbable coincidence of four wives unfaithful with three cryptorchids, the safest course is to adopt the author's own admission contained in the words, "I see no valid reason why there should not be exceptions." The rule must be held to be established.* Casper says of this class of persons, "Experience proves that cryptorchids are perfectly capable of procreation, and there are, *à priori*, no physiological reasons for doubting this." (Vol. iii. p. 256.)

Directions for conducting examinations in cases of alleged impotence:—

1. Note the age, general appearance, habit of body, and state of health, of the person complained of, and ascertain what diseases he or she may have previously laboured under.

2. Examine the sexual parts with great care; ascertain their degree of development, and explore such openings or canals as may be discovered by the sound or catheter. Ascertain the condition of the urethra of the male, and the state of the prostate.

3. No gross or indelicate manipulations need be practised, nor artificial stimulus employed.

4. These examinations can only be safely intrusted to skilful and experienced medical men. The examination of females should be conducted by accoucheurs, the jury of matrons being obviously incompetent.

RAPE.

Rape, which was formerly a capital offence, is now visited by penal servitude for life as its maximum punishment, as is also the carnal knowledge of any girl under 10 years of age. The carnal knowledge of any girl between the ages of 10 and 12 is punishable by penal servitude for three years. Indecent assaults on

* Observations on Sterility in Man, with cases. By T. B. Curling, F.R.S., Surgeon to the London Hospital, &c. 'British and Foreign Medico-Chirurgical Review,' April, 1864.

females and attempts on girls under 12, are punished by imprisonment for any term not exceeding two years. (24 and 25 Vict. cap. c. § 40 et seq.)

Rape being defined as "the *carnal knowledge* of a woman forcibly and against her will," a question has arisen as to the meaning of the term *carnal knowledge,* and a doubt has been raised whether it implies penetration and emission, or penetration only. Though this difficulty might be supposed to have been set at rest by the 9th of Geo. IV., chap. 31, which distinctly provides that neither in cases of rape, nor in offences *contra naturam,* shall it be necessary to prove the actual emission of seed, but that the carnal knowledge shall be deemed complete upon proof of penetration only, much difference of opinion continued to exist among legal writers, and conflicting decisions were given from the bench, till at length it came to be understood and universally admitted that proof of emission is not required. A question was next raised as to the meaning of the word "penetration," and it was at length decided, after further conflict of legal opinions and decisions, that any introduction of the male organ within the vulva constitutes penetration.*

The least possible introduction, then, of the male organ within the vulva, even short of the rupture of the hymen, and without the emission of semen, constitutes a rape, provided it be done forcibly and against the will of the female, and the facts to be established are:—1. Forcible penetration, in this limited sense of the term; and, 2. In the case of females above twelve years of age, that the force was used against the will of the complainant. The subject, therefore, divides itself into two parts—the question of penetration, or, in other words, the *physical signs* of rape, and the question of consent. On the first question the medical man is required to give evidence; on the second the court decides on the evidence of other witnesses.

As the law makes no distinction between the married and the single, the chaste and the unchaste, and as it does not limit the time after the alleged commission of the offence at which an accusation may be preferred, the examination of the female may have to be made under very different circumstances in different cases.

PHYSICAL SIGNS OF RAPE.

Though, after the explanation already given of the meaning of the term penetration, it is not necessary to prove the existence of any definite amount of injury (as, for instance, the rupture of the

* See Archbold's 'Pleading and Evidence in Criminal Cases.'

hymen in those who have not had previous sexual intercourse), it is incumbent on the medical man to make a minute and careful examination of the parts of generation, so as to be able to give a clear description of the injury they have sustained. And though it is not necessary to prove the fact of emission, the discovery of semen on the person of the female, or on her dress, must obviously be of very great importance.

The duty of the medical man when called on to examine the person of a female said to have been violated will therefore consist—1. In an examination of the parts of generation, with a view to an exact description of the amount of injury they have sustained. 2. In an examination of the body and limbs of the female, with a view to discover bruises, scratches, or other evidences of resistance to the alleged violence. 3. In an examination of the linen worn by the female at the time of the alleged rape, with a view to the discovery of spots of semen or of blood, and, in some cases, of other discharges. It may also be necessary to examine the person and linen of the accused.

1. *Examination of the parts of generation.*—Before considering the injuries which these parts may sustain, it will be necessary to institute a preliminary inquiry into the value of the hymen, and of other alleged signs of virginity; for, in the majority of instances, the crime of rape is committed on the person of a female who has not previously had sexual intercourse; and it is usual, in the case of adult females, to endeavour to rebut the charge of rape by alleging previous unchastity—a question on which the medical examiner may be required to express an opinion.

The Hymen.—Strange as it may appear, some authors have contested the very existence of this membrane. Male, Beck, and Devergie, give long lists of those who affirm and of those who deny its existence; but it must be admitted that the former have the advantage, both in numbers and authority.

Orfila examined more than 200 subjects, and never found it wanting. Gavard found it in the fœtus, in the new-born infant, in young women from 23 to 25 years of age, and in one of 50 years. Bennach, of Marseilles, saw it in a woman of 60. Devergie himself has found it invariably present in new-born infants, and has met with it in women of different ages exposed at the Morgue, of whom one was 65 and another 72 years old. The same author has twice observed the labia minora united through their whole extent, leaving a small aperture above corresponding to the meatus urinarius; and once he found the vagina closed by a false membrane within the labia minora, having a perfect hymen behind it. Devergie concludes, from a careful review of all his

authorities, that the hymen is an almost constant formation, recognizable by marked characters in 99 cases out of 100; and he traces the differences of opinion that have existed to the great varieties discoverable in its form and size.*

The hymen is usually found as a semilunar fold, concave before and convex behind, bounding the entrance of the vagina below, the extremities losing themselves behind the labia minora in the circumference of the orifice. Another form is that of a circular membrane, perforated in the centre, and adherent by its entire circumference. A third form consists of a membrane also filling the orifice of the vagina, but having a small opening above, corresponding to the meatus urinarius. Lastly, the most unusual form is that of filaments of mucous membrane uniting the carunculæ myrtiformes.

The hymen, which is comparatively small at birth, enlarges little by little, and especially about the period of puberty. Its free edge then becomes relaxed and thrown into folds, which, when ruptured, give rise to those small pyramidal tubercles, from three to six in number, known as the carunculæ myrtiformes, which are therefore looked upon as marks of the previous existence of that membrane.

The medical examiner should, therefore, ascertain whether the hymen is present or absent; for its recent destruction proves the recent employment of force, and if there are other marks of violence on the parts of generation and on the person of the female, there can be no reasonable doubt of the commission of a rape, as far as that crime admits of being proved by physical signs.

The destruction of the hymen gives rise to two, three, or more small tubercles on each wall of the vagina, known as the *carunculæ myrtiformes.* When the destruction is recent, they are swollen and inflamed; but they gradually wither and shrink with time. This absence of the hymen, and substitution of the carunculæ, must not be taken as proof that the female had had previous sexual intercourse; for the membrane may be destroyed otherwise than by sexual intercourse: from within, if the aperture be small, by the first menstrual flux, or by the accumulation of other discharges; from without, by accident, or by foreign bodies purposely introduced; also by disease. It may even be originally wanting, as in a case related by Capuron.

On the other hand, the presence of the hymen must not be accounted a certain sign of chastity; for it has remained intact

* Consult Devergie, 'Des Attentats à la Pudeur.'

after sexual intercourse, and even after the birth of children. Ambrose Paré, Ruisch, Osiander, Nägele, Capuron, Baudelocque, and others give cases of mothers in whom it was ruptured by the child, or divided by the knife; and Tolberg, on the authority of the elder Meckel, cites the case of a woman in whom the hymen was preserved circular and tense after the birth of a fœtus of five months, enveloped in all its membranes. Still the perfect state of the hymen, with a condition of the parts of generation and of the breasts conforming to the virgin type, affords the strongest presumption of chastity.

The presence of the hymen, then, is not conclusive proof of chastity, nor its absence of the reverse.

Besides the intact condition of the hymen, or its recent rupture, other signs of virginity have been enumerated, such as the fresh colour, firmness, and elasticity of the labia, the entire state of the fourchette, the narrowness and rugose state of the vagina, a plump and elastic condition of the breasts, the difficulty and pain attending intercourse, and the flow of blood. All these signs are fallacious. The condition of the labia just described is not always destroyed by repeated intercourse, and in the state of the breasts many widows and mothers may compare with undoubted virgins. The fourchette may remain unruptured after repeated intercourse, and even after child-bearing; and the narrow and constricted vagina is not only not peculiar to virgins, but may be imitated by the use of astringents, while the opposite state naturally present during the menstrual period, may be induced by profuse menstrual or leucorrhœal discharges. The pain attending a first connection and hæmorrhage are still more fallacious, as both may occur from relative disproportion.

The difficulty of ascertaining the fact of previous sexual intercourse, and the possibility of the usual signs of virginity remaining after long habits of unchastity, is well illustrated by the following case.*

Two young women of genteel appearance were attacked in the public streets by some young men, who called them opprobrious names, and told the passers-by that they were nothing better than common prostitutes. Some good-natured persons resented this conduct, and took the girls' part; and a complaint was lodged on their behalf against their defamers, who were summoned to appear before a magistrate. The defendants pleaded a justification, while the females, on the contrary, stoutly insisted on their purity, and even offered to submit to personal inspection by a medical examiner,—which the opposite party dared them to

* Parent-Duchatelet, 'La Prostitution dans la Ville de Paris.'

do. A sworn inspector, clever and conscientious, was appointed by the magistrate, and reported that it was totally out of his power to say anything certain in regard to one of the females; she might or she might not be a virgin; but that the other had *probably* had some intercourse with men, though he could not assert the fact positively. Yet it subsequently came out that these young women had actually been for some time on the registers of the police, and had both had repeated attacks of the venereal disease.

The physical signs of rape consist in marks of violence on the organs of generation, proportioned to the force employed, the resistance offered, and the relative disproportion of the parts. In the adult virgin the hymen will be ruptured, and the fourchette may be torn; and the parts will be found covered with blood. In young children, there may be no penetration, and therefore no destruction of the hymen, and no hæmorrhage, but bruising of the external organs. After an interval of some hours, there will be marks of recent inflammation, with increased heat and swelling of the genitals, and profuse discharge, at first of mucus tinged with blood, then of a muco-purulent fluid, of a greenish-yellow colour, and glutinous character.

These appearances will be present if the parts are inspected soon after the commission of the crime; but at the end of three or four days the inflammation will have subsided, the parts may be healed, and no trace of the injury may remain. The soreness resulting from the injuries inflicted causes a difficulty in walking, and a peculiar gait, which lasts for a day or two in the adult, but longer in children who have been much injured. There is also complaint of pain in micturition, and sometimes in relieving the bowels.

The marks of violence will be, *cæteris paribus,* less distinct, and the resulting inflammation less intense, in women who have had sexual intercourse, and in those who have borne children; also in those who are at the menstrual period, or are suffering from any profuse discharge.

It is scarcely necessary to add that these marks of injury to the parts of generation may exist, and yet no rape have been committed; for a first intercourse, with full consent, or a great disproportion of parts in the case of a woman accustomed to sexual intercourse, would give rise to the same appearances.

The possibility of injuries to the organs of generation being fraudulently produced, in order to support a charge of rape, must also be borne in mind. Thus Foderé cites a case in which inflamed spots were produced by the pressure of a coin.

Appearances on the parts of generation, similar to those due to violence, may also be occasioned by disease. We owe our first knowledge of this important fact to Dr. Percival. Jane Hampson, æt. 4, was admitted an out-patient of the Manchester Infirmary, February 11, 1791. The mother stated that the child had been as well as usual till the preceding day, when she complained of pain in making water. This led her to examine the parts, which she was surprised to find highly inflamed, sore, and painful. The child had slept two or three nights in the same bed with a boy fourteen years old, and had complained of being very much hurt by him. Leeches and other external applications, with appropriate internal remedies were prescribed; but the child grew weaker, and died on the 20th of February. A coroner's inquest was held; prior to which the body was inspected, and the abdominal and thoracic viscera being found free from disease, Mr. Ward, the surgeon attending the case, gave it as his opinion that the child's death was caused by external violence. A verdict of murder was accordingly returned against the boy with whom she had slept. Not many weeks however, elapsed, before several similar cases occurred, in which there was no reason to suspect external violence, and some in which it was certain that such violence had not been offered. A few of these patients died. Mr. Ward was now convinced that he had been mistaken in attributing the death of Jane Hampson to external violence, and informed the coroner of the reasons which had led him to change his opinion. Accordingly, when the boy was called to the bar at Lancaster, the judge told the jury that the evidence adduced was not sufficient to convict; that it would give rise to much indelicate discussion if they proceeded to the trial; and that he therefore hoped they would acquit him without calling witnesses. With this request the jury immediately complied. The disorder in these cases, says Dr. Percival, had been a typhus fever, accompanied with a mortification of the pudenda.*

A nearly similar complaint has been described by Mr. Kinder Wood. It is preceded by febrile symptoms for about three days. Attention is then called to the seat of the disease, by complaints in voiding the urine, and when the genital organs are examined, one or both labia are found enlarged and inflamed. The inflammation is of a dark tint, and soon extends over the clitoris, nymphæ, and hymen. Ulceration succeeds, and the external organs are progressively destroyed. The affection, which seemed to be a peculiar kind of eruptive fever, proved very fatal.†

* 'Medical Ethics,' pp. 103 and 231.

† 'Med. Chir. Trans.,' vol. viii. p. 84. See also Beck's 'Medical Jurisprudence,' art. Rape, for further references to authors.

Lawrence, in his 'Surgical Lectures,' also describes a peculiar kind of inflammation of the external organs of children, which is not only a serious affection in itself, but has often been confounded with syphilis, so as to give rise to the suspicion that the children had been ill-used. In some instances judicial trials of a serious nature have been the result. The disease occurs in young subjects of from four or five to eight or ten years of age; and consists of inflammation of the labia and external organs generally; which assume a deep, dusky red colour, and become the seat of foul ulcers, with a tawny gray, and sometimes an actual sloughing surface, very painful, and attended with a thin fetid discharge. They sometimes extend to a considerable portion of the surface of the external organs, and are attended with feverishness, restlessness, great pain, and very considerable disturbance of the health of the child. The disease differs widely from syphilis, and the ulcers have characters totally different from those of any primary venereal sore. Lawrence gives the case of a child suffering from this affection, who, in consequence of professional opinions that it was the venereal disease, was interrogated into the idea suggested and strongly entertained by the parents, that a certain youth had done something or other to her. He was taken to Bow-street, examined there, and tried at the Old Bailey on a capital charge of violating this young person. On that trial Lawrence gave evidence.

Wilde of Dublin describes a similar affection of the parts of generation of young children in connection with leucorrhœal ophthalmia, and adduces facts to prove that both affections are contagious.*

We have seen several cases of this deep-coloured inflammation of the genitals with profuse discharge, but not proceeding to ulceration; and have generally found the friends suspicious of violence.

Disease, therefore, may give rise to appearances on the parts of generation resembling the effects of violence. But it should be borne in mind, that it attacks only young children, and that the same disorder sometimes prevails at the same time, in the same place.

2. The evidence afforded by marks of violence on the parts of generation may derive important confirmation from an examination of the person of the female. If great violence has been used, and much resistance offered, bruises and scratches will be found on the groins, thighs, and knees, and on the arms and chest. The clothes may also be torn in the struggle.

* 'Medical Times and Gazette,' Jan. 17, 1857. See also Mr. Kesteven in same journal, April, 1859.

Marks of violence, then, on the parts of generation, corroborated by bruises and scratches on other parts of the person, form the principal physical signs of rape.

3. *Examination of the Linen.*—A careful examination of the linen worn by the female at the time of the alleged rape may furnish valuable negative evidence, or may issue in the discovery of spots or stains of blood, of menstrual fluid, of semen, or of other discharges.

Spots of blood.—When the injury is recent the linen will be spotted with pure blood, presenting a uniform red colour throughout; but when the first hæmorrhage has ceased, there will be a muco-sanguinolent discharge, producing stains less defined, reddish, or yellowish red, lighter in the centre, darker at the circumference.

The coexistence of these spots of blood, or of bloody mucus, with marks of violence, forms a strong corroboration of a charge of rape: but the absence of marks of violence would justify a suspicion of fraud.

For the chemical tests and microscopic characters of spots of blood, the reader is referred to the chapter on wounds.

The menstrual fluid.—It is necessary to be on our guard against confounding blood-stains with those produced by the menstrual discharge. This fluid is secreted by the lining membrane of the uterus. It is of a rich cherry-red colour, not brightened by contact with air, and passing by exposure to a brownish-red. It contains less fibrine than blood, and does not form so firm or thick a clot. It has a characteristic sour odour, and an acid reaction, due to the presence of free phosphoric and lactic acids. It also contains mucous globules and epithelial scales from the uterus and vagina; and is sometimes discharged with clots of blood. By these properties the menstrual fluid may be distinguished from blood, when present in any quantity and in its unmixed state. But the appearances presented by spots or stains of menstrual fluid are not so distinct, and cannot be relied upon, especially as stains of blood may themselves be blended with mucus and epithelium supplied by the secretions of the parts: and this is especially true of the soiled linen of the class on whom the crime of rape is most frequently committed. In reference, therefore, to stains on linen, it is safe to adopt the statement of Casper, "that there is no distinguishable difference between the two kinds of blood." The source of the fluid supposed to be menstrual might be ascertained by plugging the vagina. If it were found to flow from the upper part of the passage, we should be justified in inferring that it was menstrual.

If the menses were flowing at the time of an alleged rape, blood would be mixed with the discharge, and would be found adhering to the parts which had been injured, or in larger quantities near the scene of the violence.

This coincidence took place in the case of Mary Ashford, which occurred in 1817, and excited much interest at the time:—

The menses were flowing at the time of the alleged rape, and *coagulated* blood was found at the spot where the connection took place, in the middle of the impression of a figure on the grass. The parts of generation were lacerated, and covered with coagulated blood. The shirt and pantaloons of the accused, Abraham Thornton, were also bloody. He confessed the connection, but said that it was with consent. The dead body of Mary Ashford was found the next morning in a pool of water.*

Semen, and seminal spots.—When the person of a female is examined soon after a rape, semen may be discovered at the orifice of the vagina, or on the other parts of generation; or seminal spots may be found on the shift. If a fluid resembling semen is found, its real character may be determined by the microscope, which reveals the presence of certain minute bodies of very characteristic appearance, variously designated as *spermatozoa*, *zoosperms*, *seminal animalcules*, and *cercaria seminis*. These bodies exist in the semen of male animals that have reached the age of puberty. When examined under a high power of the microscope they are found to consist of a long slender filament surmounted by an oval or pear-shaped head. They are diffused through the semen in large but variable numbers, mixed with granules or corpuscles of much larger size. They are very minute, their entire length often not exceeding the 600th of an inch, and the pear-shaped head being about half the size of the human red blood-corpuscle. For several hours after the death of the animal to which they belong, the filament has a peculiar lashing, undulating, or vibrating movement. But when they have ceased to move, they may still be detected by their peculiar shape, which they retain even when dry; so that they may be discovered in dried semen if carefully moistened. They also resist putrefaction, and have been observed in putrid semen kept for ten weeks.† They have also been repeatedly detected in the liquid obtained by steeping seminal stains in a small quantity of distilled water. Devergie found them in stains ten months old, Casper at the end of a year, Bayard after three, and Ritter after four years.‡

* See this case at length in Cummin's Lectures, 'Med. Gaz.,' xxi. p. 386.

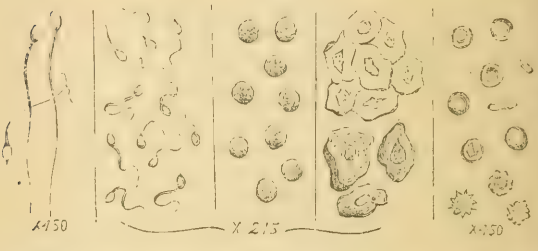
† Dr. John Dewy, 'Edinb. Med. and Surg. Journ.,' vol. iv. p. 15.

‡ A case of rape, by Dr. Henry Munroe, accompanied by an engraving

In the annexed wood-cut (fig. 5) the spermatozoa (1) and the blood disks (2) are seen magnified 450 diameters; while the spermatozoa (3), the mucous bodies (4), and the epithelium scales (5), are shown under a lower power, of 215 diameters.*

Fig. 5.

1. 3. 4. 5. 2.



Till lately these bodies were the only ones found on the person or linen of the female which had motion, and consisted of the two constituent parts—head and filamentous tail. But M. Donné has described and depicted an animalcule occasionally encountered in vaginal mucus, and especially in the discharges of females careless of personal cleanliness, which he calls Trichomonas vaginæ. It is found mixed with granular bodies of larger size than those of semen, and has the shape depicted in the annexed engraving. The head is three times the size of that of the spermatozoa; it has several granules in its interior; and a row of from four to six short cilia spring from its circumference.

Fig. 6.

But seminal spots have other characteristic properties. They are of a grayish colour, best seen by placing the linen between the eye and the light. They are stiff, as if starched; and when moistened give out the well-known seminal odour. Held near the fire—taking care not to scorch the linen—the spots change to a yellow fawn colour, and several small whitish spots, not previously perceived, make their appearance. According to Orfila, this effect of heat is characteristic: it does not take place

showing the spermatozoa, the blood globules, the epithelial scales of the menstrual discharge, and the mucous bodies as seen in the liquid obtained by steeping the stains in distilled water, will be found in Beale's 'Archives of Medicine,' vol. i. p. 139.

* 1 and 3 are from Griffith and Henfrey's 'Micrographic Dictionary;' 3, 4, and 5 after figures in Beale's 'Archives,' vol. i.

with any other healthy or morbid discharge; not with vaginal mucus or the lochia; nor with gonorrhœal discharge or fluor albus. Pure nitric acid gives to the solution of semen in water a slight tinge of yellow, but causes no precipitate.

The change of colour in the spot when held near the fire, and the peculiar odour of the solution, are highly characteristic. The absence of precipitate with nitric acid is less conclusive.* Casper commends a method of Lassaigne's, by which, on *linen* or *cotton* textures, the seminal spot, with others not caused by albuminous compounds, may be distinguished from secretions which contain albumen, and therefore sulphur. The spot is moistened with a solution of oxide of lead in liquor potassæ, and dried at 68° F. The seminal stain undergoes no change of colour, while the other stains, after a few minutes, assume a dirty yellow, or a sulphur yellow hue. (Vol. i. p. 205.)

But though the discovery of zoosperms in a seminal spot is conclusive as to its nature, it must be understood that a stain may have been caused by an emission and yet contain no zoosperms; for it appears from numerous observations on the bodies of men who have died by various forms of violence, that out of 22 young and middle-aged adults (several of them powerful and vigorous men) the organs contained numerous zoosperms in 5, few in 9, and none in 8; while of men above 50, 3 had them in large numbers, and 3 in small, while in three others, they were not discoverable. Duplay also found the zoosperms absent in 14 out of 51 old men. A vigorous naturalist 60 years of age, accustomed to the use of the microscope, examined, with Casper, his own semen after coitus, and they found every variation from no zoosperms at all to zoosperms described as innumerable, and from few or many *small* to few *large*. The facts thus industriously collected certainly justify Casper's conclusion "that though stains are proved to be of seminal origin when these specific zoosperms are found in them, yet that the absence of spermatozoa does not prove that these stains have not been caused by human semen." (Vol. iii. p. 296.)

Of the characters of seminal spots, other than the discovery of zoosperms, it should be stated that, though available when we are dealing with clean linen, they are of little value when we have to do with the soiled garments of the poor. In preparing the spot for examination, care should be taken not to destroy the zoosperms by rough usage. It should be cut out, placed in a watch-glass with a few drops of distilled water, and gently moved

* Orfila: 'Traité de Médecine Légale,' vol. i. pp. 156 et seq.

about with a glass spatula. After a quarter of an hour, a drop of the solution should be transferred by the point of the spatula to a glass slide, and examined under the microscope. The discovery of zoosperms would prove conclusive of the presence of semen; for, as Casper well remarks, "whoever has only once seen a single characteristic spermatozoon, dead or alive, can never be deceived again."

Other discharges.—The physical signs of rape may be complicated by the presence of the venereal disease, and a question may arise as to the value to be attached to this fact. As the earliest period after connection at which the disease occurs is about three days, its presence in a female examined soon after the alleged violence, would simply prove the female unchaste. If, on examination at a later period, the disease should be detected, it would prove the female unchaste if it were absent in the accused, but would form a strong corroboration of the charge if present. As we cannot certainly distinguish the discharge of gonorrhœa from the purulent or muco-purulent discharges of children, or from the highly coloured leucorrhœal discharges of the adult, we ought to be very cautious in forming an opinion as to the nature of any existing discharge. But in accusations of rape based on the existence of a purulent or muco-purulent discharge in young females, the ascertained absence of gonorrhœa in the accused, would be of the utmost importance to the defence.

The inferences drawn from the state of the parts of generation and person of the female, and of the state of the linen, may be strengthened by

Examination of the accused.—His person, if examined soon after the rape, may bear distinct marks of resistance, and the linen worn at the time may be found soiled with blood and semen. The force used may also have caused a rupture of the frænum. On the other hand, the accused may prove too weak, or of too tender, or too advanced an age to be justly chargeable with rape; or it may happen that he is impotent, in which case the charge must at once fall to the ground.

The statements of the female may sometimes derive confirmation from an inspection of the spot on which the offence was alleged to have been committed. It may bear distinct traces of a struggle, and be found covered with blood.

When death follows rape, a post-mortem examination may be required. The parts of generation, and the surface of the body, would have to be carefully examined; and the mouth should be inspected, as foreign bodies are sometimes introduced to stop the woman's cries.

Though the medical examiner may be able to prove, by inspection of the persons of the complainant and of the accused, that an act of forcible sexual intercourse has taken place, the proof of rape may still be incomplete; for the female may have consented after offering a certain resistance. The sufficiency of the resistance, and the question of consent generally, are reserved for the jury, guided by the following considerations:—The previous character of the female, and her relations with the accused; the motives which may have actuated her in bringing the accusation; the place and circumstances in which the crime was alleged to have been committed; the time that elapsed before complaint was made; whether, if other persons were near at hand, her cries were heard; and whether, if discovered, she made resistance and cried out before the discovery. The question of consent has of course no place in the case of children under ten years of age, of idiots, or of females in a state of unconsciousness, however produced.

This question of consent has sometimes been summarily answered, by alleging the utter impossibility of committing the crime on a woman in full possession of her senses, and of ordinary strength. That this, though very difficult is still possible, is sufficiently proved by Case LIV. p. 311, vol. iii. of Casper's Handbook; but as the term rape is now understood, the offence must be admitted to be possible, whenever the assailant is strong and vigorous, and especially when there is great disparity of strength. The female, too, may faint from fright, or yield to threats of worse violence.

Two questions connected with this subject still remain to be discussed. 1. Can a female be violated during sleep without her knowledge? and, 2. Does pregnancy ever follow rape?

1. *Can a female be violated during sleep without her knowledge?*—That a female may be violated during *stupor* produced by narcotics, there is no doubt; that a female, accustomed to sexual intercourse, may be violated during profound sleep, is also highly probable;* but that a virgin should be violated during sleep may be held to be in the highest degree improbable. In the absence of facts this is all that can be said on the subject. Violation is here used in the sense of forcible and complete sexual intercourse: but when discussing the question of pregnancy, cases will be cited to prove the possibility of intercourse with a

* In the year 1840, I was consulted by a poor woman, who, after mentioning other complaints of little importance, stated that she was somewhat alarmed by the fact of her sleep being so heavy that she was with difficulty roused. She added, by way of illustration, that her husband had assured her that he had frequently had connection with her during sleep.

sleeping woman being followed by pregnancy, which has taken the female by surprise—a proof that the connection was not accomplished with violence.

2. *Does pregnancy ever follow rape?*—The facts just referred to prove that pregnancy may follow unconscious connection; hence the venereal orgasm is not a *sine quâ non* of conception. It is also admitted that pregnancy may follow a first intercourse with consent; hence there is nothing in the nature of a first connection to prevent conception. It is, therefore, in the highest degree improbable that an event which may follow an act unconsciously performed, and in spite of the pain of a first intercourse, should be prevented even by the most passionate repugnance.

It now only remains to give some short directions for medico-legal examinations in cases of alleged rape.

1. Visit the female without giving her time for preparation, and proceed at once to a personal inspection. Take note of the time of the visit and of that at which the offence is stated to have been committed. Avoid leading questions, especially in the case of children.

2. Observe the age, strength, and state of health of the complainant; examine any injuries that may exist, or may be alleged to exist, on her person, and see whether they correspond with the cause by which they are said to have been inflicted.

3. Examine the organs of generation, and ascertain whether they are bloody, swollen, inflamed, abraded, or ulcerated; whether there is any discharge, and from what part it flows; whether the hymen and fourchette are injured, and if injured, whether recently, and whether the carunculæ myrtiformes are present; ascertain the date and origin of such marks of violence as exist, and determine whether they might not have been produced by other than the alleged cause, as, for instance, by foreign bodies, purposely applied to, or introduced into, the parts. Inquire, also, whether the alleged violation took place during the menstrual period, or while the female was suffering from any debilitating discharge.

4. Let any existing discharge be carefully observed, collected, and examined; and reserve for examination any spots of blood or semen found on the person or clothes.

5. If death have taken place, the body must be inspected, and search be made for bruises, fractures, or dislocations; and for foreign bodies thrust into the mouth. The internal viscera must also be examined.

6. Examine the spot on which the offence was committed.

Lastly. Examine the person of the accused; his bodily strength

and development; the parts of generation, with a view to discover whether he be impotent, or capable of producing the existing amount of injury, whether he have the venereal disease, or any recent abrasion, or rupture of the frænum. Examine his person also, with a view to discover bruises, scratches, or other marks of resistance; and his linen for spots of blood or semen.

If the joint examination of the complainant and accused does not support the charge of rape, it may justify the charge of assault with intent to commit it; and another indictment may be preferred, charging the prisoner with the misdemeanour.

PREGNANCY.

The medical man may be required to make examinations for legal purposes, not only in cases where pregnancy is truly alleged to exist, but where it is feigned or concealed.

Pregnancy may be *feigned* by the unmarried to extort money, to touch the feelings of a paramour or seducer, or to influence a jury in the assessment of damages for breach of promise; by the married, to gratify the wishes of a husband, or to produce a supposititious heir to an estate; and also, both by single and married, to stay the execution of capital punishment. Pregnancy may also be *concealed* both by married and unmarried, to avoid disgrace, to procure abortion, or to commit infanticide.

The most common occasions for examination arise at common law, when a widow, on the death of her husband, by alleging that she is with child, disappoints the heirs to the estate; and in criminal courts, when a female condemned to death pleads pregnancy in stay of execution.

The legal procedure in the first of these cases is by the issue of a writ *de Ventre inspiciendo*, the examination being intrusted to a *jury of matrons*, or discreet women, generally twelve in number, who, if they find the female to be pregnant, are charged with the duty of narrowly watching her till her delivery. In the second case, the duty of the jury is to ascertain, not only whether the female is pregnant, but also whether she is *quick with child.*

This jury has not always been constituted in the same manner; and it is now a common practice to require the aid of skilled medical examiners. Thus in the case of Mrs. Fox,* two medical men and two matrons were appointed to visit her once a fortnight: and in a criminal case (Mary Weeks, indicted for the murder of George Weeks, Western Circuit, March 20, 1856), the

* 'London Med. Gaz.,' vol. xvi. p. 697; vol. xvii. p. 191.

counsel for the defence moved for a stay of execution, as the prisoner was quick with child. Accordingly, the doors of the court were ordered to be locked, and a jury of matrons was called into the box, sworn, and charged to inquire into the fact. Two medical men were also sworn to examine the prisoner, and give evidence before the jury, who retired for a short time, and, on returning, found that the prisoner was in the condition alleged. Sentence was accordingly respited till the prisoner should be delivered.

A court of law has also interfered on proof of the pregnancy of a prisoner, application being made to admit her to bail. A case for medical examination may also arise under the act 1 Gul. IV., chap. 22, which provides that a deposition may be read in evidence when it can be shown to the satisfaction of the judge that a witness is unable, from permanent sickness or other infirmity, to attend the trial. It has been ruled that imminent delivery is a cause for examination under this act.

As the subject of pregnancy is one that involves many details, it will be examined under the following distinct heads:—1. *The signs and symptoms of pregnancy during life.* 2. *Examination of the uterus and its appendages after death, with a view to the discovery of proofs of an existing or previous pregnancy;* and 3. *Questions of a medico-legal nature connected with pregnancy*

I. SIGNS OF PREGNANCY.

The leading Signs of Pregnancy are here briefly described, the reader being referred for more accurate information to works on midwifery, or to monographs treating expressly on this subject.*

Constitutional Signs or Symptoms.—An irritable and capricious temper, melancholy, languor; a worn and dejected expression of countenance, and emaciation; nausea, heartburn, loathing of food, a capricious, variable, or depraved appetite; vomiting especially in the morning, and a costive state of bowels; feverishness, determination of blood to the head, with eruptions on the face; and in some cases salivation, and pains of the face and teeth are recognised symptoms of this state. When taken separately they have little value, and even when several coexist, they are far from conclusive.

The Breasts.—The changes in the breasts consist, (*a*) in increased size and firmness; (*b*) in the formation round the nipple of a moist dark circle, or areola, studded with mucous follicles and (*c*) in the secretion of a mixture of milk and serum which flows from the nipple.

* Consult Montgomery, 'Cyclo. of Pract. Med.,' art. Pregnancy, and his 'Signs of Pregnancy.' Also Dr. Tanner's recent work on the same subject.

The Uterus.—The signs referable to this organ are, *a.* changes in the size and shape of the abdomen; *b.* quickening; *c.* suppression of the menses; *d.* changes in the neck and orifice of the uterus; *e.* increased size of the uterus; *f.* ballottement; *g.* discoloration of the mucous membrane of the vagina; *h.* sounds heard on applying the stethoscope to the abdomen.

a. Changes in the Size and Shape of the Abdomen.—These consist in a uniform enlargement, first perceptible about the end of the third month, and progressively increasing up to the time of delivery. Before the third month the uterus sinking into the pelvis causes the abdomen to appear flattened, and the umbilicus depressed.

b. Quickening.—This is vulgarly attributed to the movements of the child, but more correctly to a sudden change in the position of the uterus, usually taking place between the 14th and 18th weeks, but sometimes as early as the 12th week. It is a very fallacious sign; for these movements may not be perceived at all, or they may be confounded with the motions of flatus, with changes in the position of the viscera, or with sudden contractions of the muscles.

c. Suppression of the Catamenia.—The menses may be suppressed for long periods, from causes other than pregnancy; or they may be present for one or two periods after conception, and even during the whole course of gestation; or, again, they may be absent at other times, and appear only after conception. Moreover, the sign is wanting in females who become pregnant without having menstruated. A woman who is really pregnant may also conceal the fact by pretending that she is regular, and imitating the catamenia by blood.

d. Changes in the Neck and Orifice of the Uterus.—The neck of the impregnated womb is full, round, soft, and elastic; the margins, or lips, lose their well-defined edge, and become soft, swollen, and indistinct; and in advanced pregnancy it becomes shorter, and is at length no longer to be felt. The orifice, instead of being transverse, becomes circular, and admits the point of the finger more readily, and to a greater depth. The womb also shifts its position as pregnancy advances; it rises higher, the fundus is tilted forward, and the neck backward.

e. Increased Size of the Uterus.—During the first three months, the womb not having yet risen out of the pelvis, no increase of size is discoverable even by examination per vaginam; but at the end of the fourth month it may sometimes be felt above the pubes; and during the fifth, both externally and per vaginam. As this enlargement of the womb may be due to any

cause gradually distending its cavity, it is not a sure sign of pregnancy.

f. Ballottement.—This name has been given to the sensation caused by the fall of the fœtus after it has been jerked upwards by a brisk movement of the finger. It is not available till after the fourth month, and rarely much beyond the end of the sixth. Its application, therefore, is limited. In practised hands it is a sign of great value.

g. Discoloration of the Mucous Membrane of the Vagina.—The mucous membrane of the vagina of the pregnant woman has a deep violet tint, like that of lees of wine. This constitutes an excellent sign of pregnancy, but one that does not admit of frequent application in this country.

h. The Stethoscope.—Two sounds may be heard on applying the stethoscope over the region of the uterus in a pregnant female; the pulsations of the fœtal heart, and the uterine murmur. The pulsations of the fœtal heart vary from 120 to 160 in a minute, and bear no relation to the pulse of the mother. Each pulse is double, and resembles the tick of a watch heard through a pillow. It is not always heard in the same place, but generally on one side, at a point nearly midway between the navel and the anterior superior spine of the ilium. It is also occasionally inaudible. When heard, it is a sure sign of pregnancy. It fails in the case of a dead fœtus, and it is inapplicable at an early period of gestation. The uterine murmur is a low murmuring, or cooing sound, such as is made by blowing gently over the lip of a wide-mouthed phial. It is synchronous with the pulse of the mother, and may generally be detected in the lateral or anterior parts of the uterus, being first distinctly audible about the end of the fourth month.

The Urine.—A glistening scum (consisting of triple phosphate and minute fungoid and confervoid growths) is found floating on the urine of pregnant women, after standing one or two days; and under the name of *Kyestein* was once deemed a certain sign of pregnancy. Though generally present in pregnancy, it has been shown to occur also in anæmic women who are not pregnant. This, then, like the fact that the urine in pregnancy often contains grape-sugar, is of little value as a sign.

Of the foregoing signs few are conclusive when taken by themselves; while many are extremely fallacious, and are liable to be simulated by various diseased conditions, or to be obscured by co-existing diseases of the uterus, or of the abdominal viscera. The best of these signs can only be duly appreciated by experienced persons, to whom alone this class of inquiries should be intrusted.

The evidence of pregnancy afforded by substances expelled from the womb may be very briefly discussed.

The chief of these substances are, 1. An early ovum. 2. Moles. 3. Hydatids. 4. False membranes.

1. *An Early Ovum.*—This may be recognised either by the characters of the contained fœtus, or by that of its membranes. The appearances presented by the fœtus itself during the early stages of its development will be examined in the next chapter. The membranes present highly characteristic appearances. The decidua is known by its soft, rich, pulpy appearance and strong red colour, its rough external surface perforated by small foramina, and its smooth internal surface. The inner decidua is known by its smooth outer surface, and its internal one covered with filaments, which receive the arborescent villi from the surface of the chorion. These appearances are never assumed by any product of disease.

2. *Moles.*—Some authors have regarded these bodies as products of conception, others as independent of sexual intercourse. If products of conception, they will be identified as such by the discovery of some constituent parts of an ovum; but if no such parts can be found, it will be right to assume that the substance under examination was not due to impregnation.

3. *Hydatids.*—There is a decided balance of opinion in favour of these being in all cases products of conception; hence they form an exception to the rule just laid down with regard to moles. It must be recollected, however, that Hydatids may spring from portions of membrane retained perhaps for several months, so that they would not serve to fix the date of the pregnancy.

4. *False Membranes.*—These are often expelled in dysmenorrhœa; and a careless observer might pronounce them products of conception. The rule already laid down, that no substance expelled from the womb should be deemed a product of conception, unless it contain constituent parts of an ovum, must be observed also in this case. For an illustration of a false membrane discharged during painful menstruation, see fig. 14, p. 73.

II. POST-MORTEM EXAMINATION.

This may become necessary, in order to determine the existence, or previous occurrence, of pregnancy, an important fact in certain medico-legal cases.

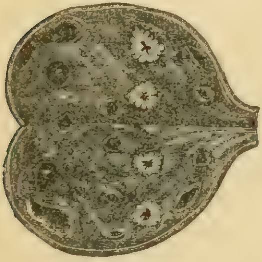
The womb, itself, by presenting the small size of the virgin state, may at once negative the supposition of pregnancy. Or it may be found enlarged, but empty, and marked by some of the changes that accompany gestation. In this case we should not

be justified in asserting that pregnancy had existed, because these appearances may be due to any tumour which had distended the organ, and formed a vascular connection with its internal surface. If the womb is not found empty, its contents must be carefully examined, and if traces of an ovum should be discovered, the fact of previous impregnation would be made out.

Much importance was formerly attached to certain appearances in the *ovaries*, as signs of pregnancy; and on the trial of Mr. Angus of Liverpool for the murder of Miss Burns, the discovery of a *corpus luteum* in the ovary was held to prove the fact of recent pregnancy, in the face of much difference of opinion as to the conclusions to be drawn from the appearance of the womb itself.

The value of the *corpus luteum* as a sign of previous impregnation has been a subject of lively discussion, and the characters which distinguish the true corpus luteum, the product of conception, from the false, as found in virgins, have been very minutely described. It results from this discussion, that the distinction between the true and the false corpus luteum is not so marked and decisive as to justify us in making a confident use of it for medico-legal purposes.* But between the corpora lutea of the adult virgin ovary, and those of the pregnant woman, the differences are such as ought to be pointed out and illustrated. Accordingly the following illustrations are appended from the able monograph of Dr. Arthur Farre.† Fig. 7 shows the longitudinal section of an adult virgin ovary, with Graafian follicles of ordinary size before enlargement, and stellate remains of follicles which have burst and shrunk after discharging their ova. In Fig. 8, 1 shows the section of an enlarged follicle, with central blood clot, from a woman who died on the tenth day after the commencement of her last menstruation; 2, the sec-

Fig. 7.

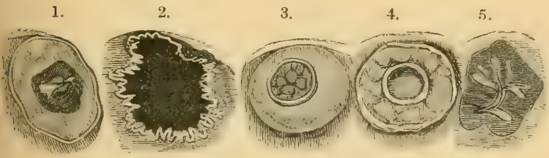


* Casper states, as the result of his many post-mortem examinations, "that the corpora lutea found after pregnancy are not be distinguished with any certainty from the corpora lutea, the result of the detachment of unfecundated ovula" (vol. iii. p. 360), and Kirkes (Physiology, 1st edit. p. 606) characterized as *unsafe* "all evidence of previous impregnation founded on the existence of a corpus luteum in the ovary."

† The Uterus and its Appendages, from the 'Cyclopædia of Anatomy and Physiology.' By Arthur Farre, M.D. Cantab., F.R.S.

tion of a large follicle which had recently burst and discharged its contents; while 3 and 4 show a superficial and a deeper section taken from the ovary of a woman who died at the end of the fourth month of gestation; and 5, the stellate follicle two days after mature delivery. The last three figures present appearances which may be deemed characteristic. They have "discharged an ovum, which has been afterwards impregnated." If the question of prior pregnancy based on the appearance of the ovaries should happen to be raised in a medico-legal case, the opinion should be obtained of some competent authority known to have carefully studied the subject.

Fig. 8.



III. MEDICO-LEGAL QUESTIONS.

These questions are—1. What are the limits of child-bearing? 2. Can a woman conceive while in a state of unconsciousness? 3. Can a woman remain ignorant of her pregnancy up to the time of delivery? 4. Does the presence of the hymen rebut the supposition of pregnancy? And 5. Is superfœtation possible?

1. *The Limits of Child-bearing.*—Cases of early fruitfulness are related by high authorities. Casper states generally that the commencement of the procreative power may be dated from the 13th to the 15th year, and its cessation from the 50th to the 52nd. (Vol. iii. p. 259.) The records of the Glasgow Lying-in Hospital contain a case of delivery at 15 years 1 month; and Montgomery delivered a female of twins before the completion of her 15th year. Dr. Wilson of Glasgow reports a case of delivery at 13½ years. Sir E. Home gives an instance of pregnancy in the 13th year; and La Motte a case of delivery before 13; the first-named author one in the 12th; Mr. Roberton a case of delivery of a still-born child in a factory girl little more than 12 years old; and Mr. Smith of Coventry one at 12 years 7 months; Bruce, in Abyssinia, and Dunlop, in Bengal, met with mothers of 11 years. Blumenbach gives an instance of pregnancy in a

Swiss girl in her 9th year (Male, p. 176); Joubert and Schurigius cases at the same early age (Smith, p. 496); and we have it on the authority of Paris and Fonblanque, that "in the year 1816 some girls were admitted into the *Maternité* at Paris, as young as 13 years. During the Revolution one or two instances occurred of females at 11, and even below that age, being received in a pregnant state into that hospital."*

On the other hand, cases are recorded of pregnancy at very advanced ages. Bartholomew Mosse mentions four cases of women pregnant in their 51st year, and Dr. Labatt of Dublin one; Knebel, La Motte, and Roberton, each one in the 52nd year; Roberton one in the 53rd year; Bartholomew Mosse, Knebel, and Roberton each one in the 54th year; a case of pregnancy at the same age (that of Mrs. Ashley) is also related in the 'Edinburgh Annual Register' for 1816. In a French case, in which the succession to an estate was disputed on the ground of the mother being 58 when the child was born, a decision was given in favour of the fact. Pliny, Valescus de Tarenta, and Marra of Venice, record cases of pregnancy at 60. The Countess de Taxis is stated to have borne a healthy child at the age of 62 (Smith, p. 496). Capuron states that a woman of 63 was generally believed in Paris to have given birth to a daughter; and, lastly, Beck quotes a case from the 'Boston Medical and Surgical Journal,' of a woman at Whitehall (State of New York) becoming a mother at 64.

It will be observed that at every age from 51 to 54 inclusive, several instances of pregnancy are recorded on undoubted authority. After this age there is a break in the chain, the earliest of the more remarkable cases having occurred at 58, and the latest at 64; and these were, for each age, solitary instances.

As the first and last appearance of the menses are usually supposed to fix the limits of possible fruitfulness, and as cases of early and late menstruation do certainly lend support to cases of early and late pregnancy, it may be well to state that menstruation at 9 years is not an uncommon occurrence in England or on the Continent; that the author, out of 1500 cases to which he directed his inquiries, found one of menstruation before the completion of the eighth year, and that Male met with two instances of regular return of the catamenia and partial development of the breast at six years of age. In one French case, menstruation is recorded at five years. The occurrence of the menstrual discharge, even in the first year of life, rests on good authority.

* See a short paper by Dr. J. G. Wilson in 'Edin. Med. Journal,' October, 1861.

On the other hand, the author has known the function of menstruation to continue uninterruptedly as late as the 57th year; and Dr. James Reid recorded instances for every year from that age up to the 69th, inclusive. Cases of menstruation recurring, after interruption, at a still more advanced age are also on record.

As the age at which the menses first make their appearance admits of medico-legal application, it may be well to state that the 14th and 15th years are the most common epoch of their commencement, then the 16th, then the 17th and 13th, then the 18th and 12th, and the other ages in the following order:—the 11th, the 19th, the 20th, the 10th, the 21st, the 22nd, the 9th, and the 23rd.

The most common period for the disappearance of the menses would seem to be from the 45th to the 50th year, inclusive; but the instances before 40 and after 50 are numerous.

2. *Can a Woman conceive while in a state of unconsciousness?*—The answer to this question is affirmative. Capuron says, "It is a fact, which experience has more than once confirmed, that a woman may become with child while in a state of hysteria, under the influence of narcotics, during asphyxia, drunkenness, or *deep sleep*, and consequently without being conscious of it, or sharing the enjoyment of the man who dishonours her." This statement is fully borne out by a case given by Capuron himself, in which the unconscious intercourse took place during a profound sleep produced by punch; by a case cited by Beck, Art. Pregnancy, in which the same result was brought about by wine; and by a third case communicated to Foderé by Desgranges, in which opium was administered with the same intent.

As examples of conception following intercourse during profound sleep, two cases may be cited, the one on the authority of Dr. Gooch, the other on that of Dr. Cusack. Of unconscious intercourse followed by pregnancy during a prolonged fainting fit, an instance was communicated to the author by Mr. Hewitt of Berkshire; and of violation with the same result during asphyxia, or apparent death, an instance is cited by Foderé (vol. i. p. 500) from the 'Causes Célèbres.'

There are, therefore, various conditions of insensibility, during which connection may take place followed by conception, the female being unconscious of the occurrence, and not suspecting it afterwards.

3. *Can a Woman remain ignorant of her Pregnancy up to the time of Delivery?*—It is obvious that in the cases just referred to this is quite possible. A woman who is not conscious of

having exposed herself to the risk of becoming a mother, would naturally attribute her enlargement, and all the attendant symptoms, to any cause but the true one. A like ignorance is perhaps possible when a female yields to solicitation under solemn assurances that, in certain circumstances, connection may take place without danger. Thus Foderé, on the authority of Desgranges, cites the case of a young girl who yielded to the solicitations of her lover, and had connection with him in a bath, under the assurance that in that situation she ran no risk. She became a mother, but seemed to remain ignorant of her situation till the last, and assured Desgranges that the circumstance of the intercourse having taken place in the water had removed all idea of pregnancy.* An opinion also prevails that a single coitus is unattended with danger; and that provided the act be incomplete, and the hymen uninjured, impregnation is impossible. Foderé also refers to cases in proof of the confidence placed by women in the precautions they had taken.

In all such cases it is possible, though unlikely, that a female may attribute her symptoms to disease, and really believe what she so much desires should be true, the wish in this, as in other things, being father to the thought; and as the married woman, anxious for offspring, construes every unusual sensation into a sign of pregnancy, and makes serious preparations for the event which is to crown her wishes, so the single woman, whose wishes all tend the other way, may sincerely attribute to any cause but the true one, every symptom of a state which threatens her with exposure. But even married women who have no motive to misunderstand or misrepresent their true condition, may, up to the very last, attribute it to a wrong cause. The conditions under which this is most likely to happen are such as occurred in a case reported by Dr. Tanner. A lady 42 years old, and married three years, after menstruating scantily for five or six months previously, had ceased to be unwell for about nine months, was taken in labour and delivered by instruments of a mature female infant. Both parents, though anxious for children, despaired of having them, and the lady had no suspicion that she was pregnant, and received with unaffected incredulity the statement that she was not only in that state, but had been in labour for ten hours.†

But perhaps the most remarkable instance on record of preg-

* Foderé, vol. i. pp. 496-7. Beck quotes this case as illustrating the position that ignorance of pregnancy may exist "when the female is an idiot." But though Desgranges describes the girl as "assez niaise," there seems no good reason to regard her as an idiot.

† A Case of Unsuspected Pregnancy and Labour. By Thomas Hawkes Tanner, M.D.: 'Trans. of the Obstetrical Society of London,' vol. iv. 1863.

nancy ignored, if not by the female herself, at least by those most likely to suspect her, was furnished by the Hawkins' divorce case tried before the House of Lords, May, 1852. The husband, after an absence of ten months from England, rejoins his adulterous wife, cohabits with her for more than two months, and even sleeps with her up to within five minutes of her delivery—a circumstance the more extraordinary as he had already cohabited with her during two previous pregnancies. Nor was the true state of the case suspected by any of her friends and acquaintances, her maid who had dressed and undressed her up to the night of her confinement, or by her medical men, the alteration that had taken place in her personal appearance having been uniformly attributed to illness. Indeed, it was by medical advice that she remained in England while her husband served abroad. Singular as the facts of the case were, the Lord Chancellor expressed his belief that the petitioner was wholly unconscious of his wife's state till she gave birth to the child.

4. *Does the presence of the Hymen rebut the supposition of Pregnancy?*—This question is answered by the facts quoted at p. 40, proving that the hymen may survive repeated intercourse, and not be destroyed even by delivery.

5. *Is superfœtation possible?*—This question will be found discussed under the head of Legitimacy, to which it properly belongs.

DELIVERY.

Delivery, like pregnancy, may be either concealed or pretended;—concealed, with a view of hiding shame, or destroying the child; pretended, in order to produce a supposititious heir to an estate, to influence the feelings of a paramour with a view to marriage, or to satisfy the wishes or appease the anger of a husband.

The medical man, then, may be required for medico-legal purposes to ascertain the existence of delivery in concealed cases, and its non-existence in pretended cases. The latter class is comparatively rare; but the former is of frequent occurrence, especially in accusations of infanticide, when the suspected mother has to be examined to determine whether she has been recently delivered. A similar inquiry may have to be instituted in the dead. It may also be necessary to determine whether a female has borne children at a former period. A question may also be raised (especially in trials for infanticide) as to the possibility of a woman being delivered while unconscious, or in such a position

and in such circumstances as, without any criminal act of her own, to endanger the life of her offspring.

This subject, therefore, resolves itself into four divisions:—1. *The signs of recent Delivery in the Living.* 2. *The signs of recent Delivery in the Dead.* 3. *The signs of a previous Delivery.* 4. *Other medico-legal questions connected with Delivery.*

I. SIGNS OF RECENT DELIVERY IN THE LIVING.

When an examination is made within a few days after delivery, the following appearances are present:—The *face* is pale, as in one recovering from a slight illness, and the eye sunken and surrounded by a dark circle. The pulse is quickened, and the skin, soft and warm, is moistened with sweat of a peculiar and unpleasant odour. The *breasts*, especially on the third or fourth day, are found full, tense, and knotty. The nipples are turgid, and the areola presents the appearances proper to the state of Pregnancy. The breasts when pressed or drawn yield a milky fluid, which presents microscopic characters of some practical value in connection with delivery as well as with infanticide. The figures annexed compare the *colostrum* from a healthy

Fig. 9.

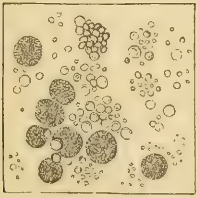
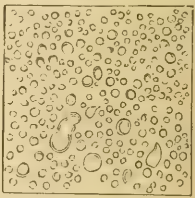


Fig. 10.



woman 12 hours after delivery (fig. 9), with the milk of another healthy woman after the lapse of a week* (fig. 10). The *abdomen* is distended, its integuments are relaxed and thrown into folds, and its lower part, from the pubes to the navel marked by light-coloured broken streaks or cracks. On pressing the hand firmly over the pubic region, the imperfectly contracted uterus is felt about the size of the head of a new-born infant, rising three or four inches above the brim of the pelvis, and inclining more to one side than the other. The *external parts of generation* bear distinct marks of distension and injury. They are swollen and

* After 'Day's Physiological Chemistry,' Plate V.

relaxed, and not uncommonly bruised and torn. After a first labour, the fourchette is often ruptured, and the injury sometimes extends deep into the perineum. On examination *per vaginam* the *uterus* is found enlarged, and corresponding with the external tumour, the os uteri gaping, so as to admit two or three fingers, and its margins relaxed, flabby and fissured. If the examination is made within a few hours of delivery, the orifice is so open that its margin cannot be distinguished, and it seems a continuation of the vagina. The vagina itself is also dilated and relaxed, and its inner surface smooth from the obliteration of the rugæ. At the time of delivery much pure blood escapes from the torn vessels of the womb, and for the first two or three days, but sometimes much longer, a bloody discharge (*the lochia*) flows from the genitals. This, when no longer mixed with the blood first discharged, is found to be destitute of fibrine, though rich in blood-corpuscles, various epithelium scales, pus-cells, and fatty globules. It then, for about the same length of time, becomes nearly colourless, or acquires a light brown or dirty greenish hue, whence the vulgar name "green waters," and has a peculiar, sour odour, resembling that of fish-oil—an odour very difficult to conceal or destroy. This is succeeded by a milky mucous discharge, which continues for four or five weeks.

The value of these signs depends upon their being found in combination. The uterus and vagina may be enlarged, and the external parts distended by any tumour recently expelled. A discharge may flow from the genitals, and the breasts may enlarge and secrete milk, from sympathy with the distended uterus. The abdomen, also, may display all the marks of recent distension.

The examination should be made without delay; for the signs may disappear before the tenth day; and, as a general rule, no satisfactory results are to be expected after that date. It may even be difficult to give a decided opinion before this period has elapsed, especially if the fœtus be small and the mother vigorous. In cases of early abortion, the appearances are slight and evanescent, and before the end of the second month no evidence of recent abortion would be discoverable.

II. SIGNS OF RECENT DELIVERY IN THE DEAD.

The external parts have the same appearance in the dead as in the living. On opening the abdomen, the uterus is found to present different appearances, according to the time that has elapsed between delivery and death. If death has taken place immediately after parturition, the os uteri will be found wide open, and the womb itself flat and flabby, from 9 to 12 inches long, its

cavity containing large clots of blood, its inner surface lined by the soft and pulpy remains of the decidua, and the attachment of the placenta distinctly visible, characterized by the dark colour, the small number of flocculi, and the semilunar openings on its surface.

The size of the womb at periods more remote from delivery varies with the degree of contraction. In the first two or three days after delivery of a mature child, it is about seven inches long by four broad; its external surface is vascular, and marked by purple patches; and when divided it is found to be from an inch to an inch and a half thick, of the colour and consistence of firm muscular fibre. Its internal surface retains the appearances just described. At the end of a week it is between five and six inches long and about an inch thick; less vascular, but more firm. The inner surface is still bloody, and partially covered by decidua. At the end of a fortnight the length does not exceed five inches, and after the lapse of a month, it has resumed its original size, but the os uteri never closes so completely as in the virgin state. The Fallopian tubes and one or both of the ovaries are found turgid and vascular, and on being cut into present one or more corpora lutea.

III. SIGNS OF A PREVIOUS DELIVERY.

The external marks consist of silvery lines, or "shining broken streaks, like the remains of cracks," on the skin of the breasts and abdomen, and especially in the groins. These marks are often absent, and when present merely indicate great previous distension followed by sudden subsidence. The marks on the abdomen are, for obvious reasons, the most fallacious; but those on the breasts are very unlikely to be caused by any other form of distension. When the two coexist they furnish strong evidence either of a former delivery, or of some distension of the womb producing sympathetic enlargement of the breasts. An experienced hand will detect in the os uteri a peculiar, jagged condition, on which much stress has been laid. The marks of a previous rupture of the fourchette or perineum would also confirm the evidence derived from the external examination of the abdomen and breasts. On the other hand, we may find very decisive negative evidence in a state of imperforation or narrowness quite inconsistent with either pregnancy or delivery. A perfect hymen would also afford a presumption against a previous delivery. (See p. 40.) The following case illustrates the difficulty that may exist of proving the fact of a previous delivery:—"We very lately examined a patient who had borne five children, and nursed three of them, the youngest being now

five years old; the breasts were small, but neither flaccid nor pendulous; the nipples short, with not the least shade of brown colour in the areolæ, which exhibited only the delicate rose colour so often observed on that part of the virgin breast; there were neither lines nor spots of any kind on the abdomen; the os uteri was small and natural; the vagina contracted, and the fourchette perfectly entire. It should be mentioned that this lady never carried her children beyond the end of the eighth month."*

4. *Other Medico-legal Questions connected with Delivery.*—Two such questions still remain to be examined. 1. Can a woman be delivered in a state of unconsciousness? 2. Can a woman, if alone and without assistance, prevent her child from perishing after delivery? The first of these questions will be examined in this place; the second belongs more properly to the subject of Infanticide.

Can a woman be delivered in a state of unconsciousness? This question can be answered in the affirmative. The event may happen under the influence of narcotics or ardent spirits; and during coma, delirium, or puerperal convulsions, attacks of apoplexy, deep sleep, and suspended animation. Cases of unconscious delivery are not very likely to happen in a female pregnant for the first time; but in women who have borne many children, and have naturally easy deliveries, such an event is more probable.

* Montgomery: 'Cyclo. Pract. Med.,' vol. iv. p. 504.

CHAPTER III.

FŒTICIDE. INFANTICIDE. LEGITIMACY.

These subjects cannot be understood without a preliminary knowledge of the growth and development of the Embryo and Fœtus.

GROWTH AND DEVELOPMENT OF THE FŒTUS.

It used to be asserted that a distinct ovum containing a defined embryo cannot be discovered in the womb before the 20th or 22nd day; but Velpeau* saw three ova not more than twelve days old, and Sir E. Home found a very minute ovum in the womb only eight days after impregnation.† The following account of the development of the embryo is based chiefly on the description of Devergie,‡ with the estimates of length and weight given by Hamilton, Burns, Capuron, Chaussier, Maygrier, Foderé, Orfila, Devergie, and Velpeau, and Bichard's measurements of the fœtal skeleton; the French measures and weights being reduced to the English standards.

Embryo, Three to Four Weeks.—Length, about $\frac{1}{3}$ inch. *Weight*, about 20 grains. *Size*, that of a large ant, or a barley-corn. *Form*, that of a serpent, the head indicated by a swelling, the caudal extremity slender, and ending in the umbilical cord; the mouth indicated by a cleft; the eyes by two black points; the members appearing as nipple-like protuberances. The villosities of the chorion uniformly spread over the surface.

Six Weeks.—Length, from half an inch to less than an inch. *Weight*, from 40 to 75 grains. The head distinct from the thorax, and the face from the cranium, and the apertures of the nose, mouth, eyes, and ears perceptible; the hands and forearms in the middle of the length, and the fingers distinct; the legs and feet situate near the anus; a distinct umbilicus for the at-

* 'Embryologie,' p. 50. † Gooch's 'Midwifery,' p. 88.
‡ 'Médecine Légale,' art. Infanticide.

tachment of the cord, which consists of the omphalo-mesenteric vessels, of part of the urachus, and of the intestinal tube, and of filaments which represent the umbilical vessels. The placenta forming; the chorion and amnion still separate; the umbilical vesicle very large. *Points of ossification* in the clavicle and maxillary bone.

Two Months.—Length, variously stated at from $1\frac{1}{2}$ inch to 4 inches. *Weight*, 2 to 5 drachms. Rudiments of nose, lips, and eyelids; organs of generation visible: arms and legs detached from trunk; anus marked by a dark spot; rudiments of lungs, spleen, and supra-renal capsules; cæcum behind the umbilicus; digestive canal withdrawn into the abdomen; urachus visible; chorion beginning to touch the amnion at the point opposite the insertion of the placenta, which begins to assume its regular form; umbilical vessels becoming twisted. *Points of ossification* in frontal bone and ribs.

Three Months.—Length, variously stated at from 2 to 6 inches. *Weight*, from 1 ounce to 3 ounces. The head voluminous; the eyelids and lips in contact; membrana pupillaris visible; fingers separated; lower extremities longer than rudimentary tail; parts of generation prominent, and the sex distinguishable by the lens; thymus and supra-renal capsules present; the ventricles of the heart distinct. The decidua uterina and reflexa in contact; the funis containing umbilical vessels and a little gelatinous matter; placenta completely isolated; the umbilical vesicle, allantois, and omphalo-mesenteric vessels have disappeared.

Fœtus of Four Months.—Length, variously stated at from $4\frac{1}{2}$ to $8\frac{1}{2}$ inches. *Weight*, $2\frac{1}{2}$ or 3, to 7 or 8 ounces. Skin rosy, and tolerably dense; mouth very large and open; membrana pupillaris very evident; nails appearing; sex distinct; gall-bladder appearing; meconium in duodenum; cæcal valve visible; umbilicus near the pubes. Complete contact of chorion and amnion; membrane forming at point of attachment of placenta to uterus. *Points of ossification* in inferior parts of sacrum; ossicula auditoria ossified.

Five Months.—Length, variously stated at from 6 to $10\frac{1}{2}$ inches (a still-born male 13, female $13\frac{1}{2}$; male born alive 9, female 10, inches). *Weight*, 5 or 7 ounces to 1 pound 1 ounce. (A still-born male, 1 pound 13 ounces [Schmitt]; two still-born twin females, 1 pound 6 ounces, and 11 ounces [self]). Volume of head still comparatively great; nails very distinct; hair of the head showing as a light down; skin without sebaceous covering; heart and kidneys very voluminous; gall-bladder distinct; meconium of a yellowish-green tint at commencement of

large intestines. *Points of ossification* in pubes and os calcis; germs of the permanent teeth.

Six Months.—*Length*, variously stated at from 8 inches to $13\frac{1}{2}$ inches. *Weight*, 1 lb. to 2 lbs. 2 oz. Skin has some appearance of fibrous structure, and is covered with down and sebaceous matter; the body of the colour of cinnabar; eyelids still agglutinated; membrana pupillaris still existing; funis inserted a little above the pubes; meconium in upper part of large intestines; liver of dark-red colour; gall-bladder contains insipid serous fluid; testes near kidneys. *Points of ossification* in the four divisions of the sternum. Middle point of body at lower end of sternum.

Seven Months.—*Length*, variously stated at from 11 inches to 16 inches. *Weight* 2 lbs. to 4 lbs. 5 oz. Skin a dusky red, thick and fibrous, and covered with sebaceous matter; hair about $\frac{1}{4}$ inch long; nails not reaching to ends of fingers; eyelids no longer adhering; membrana pupillaris disappearing; meconium occupying nearly the whole of the large intestine; left lobe of liver almost as large as right; gall-bladder containing bile; brain firmer; testicles more distant from kidneys. *Point of ossification* in the astragalus. Middle point of body a little below the sternum.

Eight Months.—*Length*, 14 inches to 18 inches. *Weight*, 3 lbs. 4 oz. to 5 lbs. 7 oz. Skin rosy, covered with fine short hairs, and with well-marked sebaceous envelope; nails reaching ends of fingers; membrana pupillaris has disappeared; testicles descend into the internal ring. *A point of ossification* in the last vertebra of the sacrum. The middle point of the body nearer the umbilicus than the sternum.

Nine months, or Full Term.—*Length*, 16 to 20 inches. *Weight*, 4 lbs. 5 oz. to 7 lbs. The head covered with hair about an inch long; skin coated with sebaceous matter; the down absent, except about the shoulders; testes have passed inguinal ring, and are often found in scrotum; meconium at termination of large intestine. *Point of ossification* in centre of cartilage at lower end of femur; os hyoides not ossified; four portions of occipital bone distinct; external auditory meatus cartilaginous.

As the growth and development of the fœtus has an important bearing on the subjects of this chapter, and the estimates just given are obviously too general, I have prepared two tables founded on the accurate observations of different authors, and presenting not only the average weights and measures but the two extremes; for it is obvious that the extreme values which

have hitherto been so much neglected in all numerical investigations, are often those most required.*

Of the following tables, the first (p. 70) presents the ascertained weight of the fœtus at the several ages specified, the second (p. 71) the ascertained length. In both tables the still-born are distinguished from those born alive: among the latter those only being included who had survived their birth one week or less. The foreign weights and measures have been reduced to the English standard, fractional parts of an ounce being omitted. The number of observations is stated, in order that the value of the results may be better appreciated, and that fresh observations may at any time be added.

The weight of the fœtus at full term has been made the subject of many investigations, and as it is important in itself, and interesting as throwing light upon the probable limits of variation at earlier periods of gestation, the results, as deduced from upwards of 20,000 observations, by Quetelet, Camus, Lécieux, and Baudelocque, and by Drs. Macaulay and Clark, including the facts in the table, are subjoined:—

Greatest, 14 lbs.; least, 2 lbs. 6 oz.; average, 6 lbs. 11 oz.

Weights have been recorded greatly exceeding even the maximum now stated. Dr. Merriman records one exceeding 14 lbs., Sir Richard Croft one, and Dewees two, of 15 lbs., Dr. Ramsbotham, senior, and Dr. Moore of New York, instances of 16½ lbs., and Mr. Owens, of Ludlow, one of 17 lbs. 12 oz. Even this great weight is said to have been exceeded.

The length of the fœtus at full term, as given by different English and French authors, is shown in the subjoined statement:—

Greatest, 26 inches; least, 17 inches; average, 19 inches.

Cases are recorded in which the length has exceeded even this maximum. Dewees, for instance, met with a length of 27 inches.

It may be well to add that, as a general rule, still-born children are heavier and longer than those born alive, males than females, single children, *cæteris paribus*, than twins, and twins than triplets.

The signs of maturity and immaturity will be gleaned from the foregoing history of the development of the fœtus; and they will be stated more fully under the head of legitimacy.

* A large collection of facts and figures relating to the growth and development of the fœtus will be found in Casper's Handbook, vol. iii. p. 18 et seq.

Greatest, Least, and Average Weights of the Fœtus at different periods of Utero-gestation.*

SEX.		Six Months.			Seven Months.			Eight Months.			Nine Months.		
		Still-born.	Born alive.	Both.	Still-born.	Born alive.	Both.	Still-born.	Born alive.	Both.	Still-born.	Born alive.	Both.
		4, 8, 12, obs.	7, 11, 18, obs.	11, 19, 30, obs.	15, 19, 36, obs.	20, 19, 43, obs.	35, 38, 79, obs.	20, 18, 43, obs.	31, 22, 57, obs.	51, 40, 100, obs.	70, 58, 143, obs.	135, 88, 218, obs.	205, 146, 391, obs.
		lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs oz
Male	max.	2 14	2 10	2 10	4 12	6 2	6 2	7 5	7 15	7 15	13 11	11 15	13 11
	min.	1 9	0 14	0 14	2 0	1 9	1 9	2 13	2 2	2 2	2 6	2 8	2 6
	mean	2 5	2 1	2 2	3 10	3 7	3 8	4 11	4 2	4 5	7 5	6 0	6 8
Female	max.	3 13	2 16	3 13	5 4	5 5	5 5	6 4	7 7	7 7	12 7	14 0	14 0
	min.	0 14	1 4	0 14	1 5	2 4	1 5	2 2	1 15	1 15	3 15	2 12	2 12
	mean	2 1	2 3	2 2	3 6	3 9	3 8	4 3	4 6	4 5	7 6	5 8	6 4
Male and Female	max.	3 13	2 16	3 13	5 4	6 2	6 2	7 5	7 15	7 15	13 14	14 0	14 0
	min.	0 14	0 14	0 14	1 5	1 9	1 5	2 2	1 15	1 15	2 6	2 8	2 6
	mean	2 1	2 2	2 2	3 8	3 7	3 8	4 7	4 4	4 5	7 5	6 1	6 8

* This table is founded upon 293 observations by Lécieux, 93 by Schmitt, 74 made under the direction of Bernt, 17 by Orfila, 16 by Devergie, 19 by Haartmann, 11 by Joerg, 20 by Dr. Taylor (of which a large proportion are contributed by Dr. Geoghegan of Dublin), and 17 by the author. Smaller numbers of facts have been borrowed from Jäger, Mörrike, Dr. Brady, and others. For exact references to the authors, see 'Ed. Med. and Surg. Journal,' Nos. 140 and 150. One case in which the weight at six months amounts to 5 lbs. $1\frac{1}{2}$ oz. is omitted from the table, as the figures are obviously too high, and must be considered as originating in an error or misprint.

Greatest, Least, and Average Lengths of the Fœtus at different periods of Utero Gestation.*

SEX.		Six Months. Still-born. 3, 2, 5, obs.	Six Months. Born alive. 2, 2, 4, obs.	Six Months. Both. 5, 4, 9, obs.	Seven Months. Still-born. 7, 9, 16, obs.	Seven Months. Born alive. 10, 9, 22, obs.	Seven Months. Both. 17, 18, 33, obs.	Eight Months. Still-born. 10, 6, 17, obs.	Eight Months. Born alive. 13, 8, 26, obs.	Eight Months. Both. 23, 14, 43, obs.	Nine Months. Still-born. 17, 33, 82, obs.	Nine Months. Born alive. 57, 32, 99, obs.	Nine Months. Both. 104, 65, 181, obs.
		in. lin.	in. lin.	in. lin.	in. lin.	in. lin.	in. lin.	in. lin.	in. lin.	in. lin.	in. lin.	in. lin.	in. lin.
Male	max.	14 6	14 0	14 0	16 7	17 3	17 3	19 0	19 9	19 9	22 11	23 6	23 6
	min.	10 6	14 0	10 6	11 11	12 6	11 11	16 0	14 9	14 9	16 7	17 1	16 7
	mean	12 11	15 6	14 0	14 7	15 5	15 1	17 7	17 0	17 3	20 0	19 6	19 9
Female	max.	16 1	14 6	16 1	16 7	16 6	16 7	18 8	17 10	18 8	22 4	24 0	24 0
	min.	12 10	14 0	12 10	13 0	12 6	12 6	16 7	15 6	15 6	17 0	16 6	16 6
	mean	14 5	14 3	14 4	15 1	14 2	14 7	18 1	16 7	17 2	19 9	19 5	19 7
Male and Female	max.	16 1	14 6	16 1	16 7	17 3	17 3	19 0	19 9	19 9	22 11	24 0	24 0
	min.	10 6	14 0	10 6	11 11	12 6	11 11	16 0	14 9	14 9	16 7	16 6	16 6
	mean	13 7	14 11	14 2	14 10	14 11	14 11	17 8	16 11	17 2	19 11	19 4	19 7

* This table is founded upon 271 observations, of which 98 were by Schmitt, 70 were made under the superintendence of Bernt, 26 by Devergie, 17 by Billard, 21 by Dr. Taylor (including those contributed by Dr. Geoghegan), and 24 by the author. A few scattered measurements made by Orfila, Madame La Chapelle, &c., complete the number. One instance of 17 in. 1 lin. at the sixth month, and another of 9 in. 10 lin. at the seventh month, are omitted from the table, as being greatly above and below all the other figures for the same ages.

N.B.—It will be observed that the number of observations given in the second line at the head of these tables does not always correspond to the sums of the previous figures. This arises from the introduction of the weights and measures of children of which the sex was not stated.

FŒTICIDE, OR CRIMINAL ABORTION.

The crime of abortion consists in unlawfully administering to any woman, or causing to be taken by her (whether she be with child or not), with intent to procure her miscarriage, any poison or other noxious thing, or using for the same purpose any instrument or other means whatsoever; also in the use of the same means with the same intent by any woman being with child (24 & 25 Vict. cap. c. § 58, 59). It will be observed that the statute is silent as to the distinction between women *quick* and *not quick* with child.

The first duty of the medical examiner is to establish the fact of abortion by examining any substances which may have been discharged from the womb. Having ascertained that they are products of conception, he may be required to determine whether the abortion was due to natural causes, to the use of drugs, or to violence. In rare instances, also, he may have to examine the female in whom the abortion is alleged to have taken place, in order to determine whether or not she has been recently delivered. Three different examinations therefore may be required.

1. An examination of substances expelled from the womb.
2. An inquiry into the cause of the abortion: and
3. An examination of the female supposed to have miscarried.

1. *Substances expelled from the Womb.*—It is only in the early periods of gestation that this examination will offer any difficulty. When the embryo has attained a certain degree of development, its appearance is quite characteristic. The rule already laid down (p. 55), in speaking of moles and false membranes as signs of pregnancy, must be observed in cases of alleged abortion, viz. to admit no substance to be a product of conception in which distinct traces of an ovum cannot be recognised. To this rule hydatids form a solitary exception.

Fig. 11.

The annexed figures from Hunter's 'Gravid

Uterus,' show the appearance of early ova, in contrast with that of a false membrane discharged in dysmenorrhœa. Fig. 11 exhibits a complete ovum of about three weeks, with bristles A B, A B, traversing the cavity from the angles A, A, corresponding to the Fallopian tubes to the point opposite the neck of the uterus. Fig. 12 shows the same ovum with much of its anterior wall cut away. A small hydatid which complicated the figures unnecessarily has been omitted. The two figures are reduced to about two-thirds of the original. Fig. 13 shows an ovum of about eight weeks, consisting of the chorion and its contents, without the decidua. The size of the figure is the same

Fig. 12.

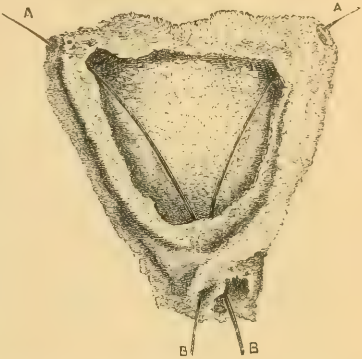


Fig. 13.

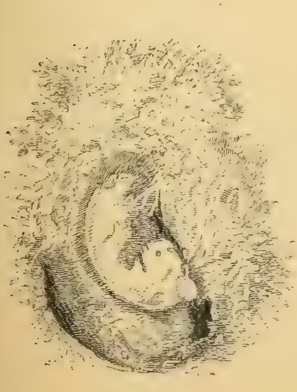


Fig. 14.

as in the original. Fig. 14 represents a portion of the lining membrane of the uterus cast off during painful menstruation. It presents all the characters of a true decidual structure, having on the side which corresponded with the uterine cavity a fine cribriform surface, and on the reverse side the rough flocculent appearance characteristic of the outer surface of membranes ordinarily discharged, along with the ovum, in abortion.

Having ascertained that the substance submitted to our inspection is really a product of conception, we must next determine its age by comparing it with the description already given of the growth and development of the embryo and fœtus, p. 66 et seq.

2. *Cause of the Abortion.*—In considering the cause of an abortion attributed to drugs or force, it is necessary to be armed with some preliminary knowledge respecting the occurrence of abortion from natural causes. This is known to be very common, especially in the early months, and it has been variously stated as occurring in 1 out of 12, or even (Dr. Granville) 1 in 3 of the total number of conceptions. Accoucheurs who have had to deal chiefly with women in more advanced periods of pregnancy have estimated the proportion much lower (*e. g.*, 1 in 188, Madame La Chapelle). The causes of these miscarriages will be conveniently considered under the title of

Natural Causes.—These are either (*a*) *predisposing*, or (*b*) *exciting*. *a.* The *predisposing* causes may affect either the female herself or the ovum. The females most liable to abortion are the plethoric, the irritable, the nervous, the lymphatic, the feeble, and the ailing; also those suffering from excessive or irregular menstruation and leucorrhœa; from syphilis, scurvy, asthma, and dropsy, and from malignant diseases. Malformations of the pelvis, its small size in those who marry very early, tight lacing, and all diseases of the womb or its appendages which restrain the complete development of the organ, also act as predisposing causes. To these may be added, rigidity of the womb in those pregnant for the first time at a mature age, and a relaxed condition of the neck. Occasionally, abortion has been epidemic.*

The predisposing causes dependent on the state of the ovum are very numerous, especially in the early months. According to Velpeau, of upwards of 200 embryos expelled before the end of the third month, at least one half were diseased. The disease may be in the membranes, in the placenta, or in the fœtus itself; and it may assume any form of structural degeneration. Disease of the fœtus, or its annexes, affords, of course, a strong probability in favour of abortion from natural causes.

* See references to such epidemics in Velpeau's 'Art des Accouchemens,' art. Avortement.

A woman who has once miscarried is likely to miscarry again from the same cause, and at or about the same period of gestation; and it is usual to attach some importance to the mere force of habit. In a case given by Heberden ('Commentaries,' p. 15), there were no less than 35 miscarriages.

b. To the *occasional*, or *exciting* causes, belong strong and sudden actions of the muscles of the abdomen, as in coughing, straining efforts to void urine or fæces, &c.; violent exercise, as in dancing; profuse discharges from the bowels or from the womb itself; undue excitement of the genital organs; blows, and various forms of mechanical injury.

All these occasional or exciting causes fail to produce abortion when the ovum is sound, and the female healthy; while the most careful abstinence from all exciting causes will not prevent abortion when the predisposition from either cause is strong.

The *criminal means* are best divided into two classes, *general* and *local;* the first acting through the constitution of the mother; the second by immediate application to the abdomen or uterus.

1. *General, or Constitutional. Venæsection.*—The confidence placed by the vulgar in this remedy rests, like many other popular fallacies, on high medical authority—that of Hippocrates. But it is a notorious fact that pregnant women bear blood-letting well, and that it is often the best means of averting a threatened abortion. The assumption that blood-letting promotes abortion is moreover rebutted by numerous well-attested facts. Cases are recorded of women bled 48, 80, and 87 times in the course of their pregnancies, without miscarriage; and Dr. Rush, who bled very freely in the yellow fever of 1793, asserts that not one pregnant woman to whom he prescribed bleeding died or miscarried.

The popular belief in the efficacy of bleeding from the foot rests on no better foundation, nor does the removal of blood by *leeches* to the *anus* or *vulva*—a practice rarely resorted to in this country—possess any peculiar efficacy.

Emetics.—It is well known that during the early months of pregnancy, and even in some instances throughout its entire duration, severe and distressing vomiting occurs, without producing abortion. This fact, coupled with the failure of several active irritant poisons productive of violent vomiting to cause miscarriage, affords some presumption against the efficacy of emetics, except in women strongly predisposed.

Cathartics.—These remedies, too, may be given repeatedly, and in very large doses, without producing abortion, except, as before, in women strongly predisposed. Dr. Rush's experience in the yellow fever of 1793 is conclusive on this point.*

* 'Med. Observations and Inquiries,' vol. iii. p. 249.

Diuretics.—These remedies are mentioned as calculated to produce abortion, but without sufficient reason. Irritant poisons, which act in moderate doses as diuretics (*e. g.*, nitre), may occasion abortion; but not simply by their diuretic action.

One of the irritant poisons specially deserves notice in this place: namely, *cantharides.* For it is a strong emetic and purgative, and an effective diuretic, acting violently on the organs in the immediate neighbourhood of the womb, viz., the bladder and rectum, occasioning also intense fever and great weakness; and yet even this drug in full doses may fail (as in a case related by Mr. Lucas, of Leeds). The frequent failure of such active poisons renders the efficacy of less powerful remedies extremely doubtful, where there is no decided predisposition to miscarry.

Emmenagogues.—Under this name a vast number of active and inert remedies are classed, most of which have as little effect on the womb as on other parts of the body. *Savin, mercury, snakeroot,* and *pennyroyal*, have been classed under this head.

Snakeroot and pennyroyal do not appear to be very efficacious. Mercury and its preparations, even when given in large doses, so as to cause profuse salivation, appear to be attended with little risk. But the *savin* has some pretensions to be considered a dangerous drug: for, in common with other irritant poisons, it has undoubtedly occasioned abortion in more than one instance, though it has failed in others, and in others, again, has killed both mother and child.

Closely allied to the so-called *emmenagogues* is the *secale cornutum*, or ergot of rye, which possesses the remarkable property of exciting the muscular fibres of the uterus to contract, and is in frequent use for that purpose. Concerning the efficacy of this remedy, much difference of opinion exists. Some authors have supposed that the power of the ergot is limited to the period of delivery, and to the state of full expansion and development of the uterus. But this opinion is refuted by cases in which it produced abortion at an earlier period of gestation; and experiments on animals have shown that it may be effectual at any period. On the other hand, several cases are recorded by Drs. Condie and Beck, in which repeated large doses of ergot, failed to produce abortion.

The root of a plant called the *Actæa racemosa* has the reputation of being nearly as active as the ergot.

Digitalis has been classed among abortives on the strength of a case related by Dr. Campbell. The drug was given for dropsy; the child was still-born, and the mother died soon after. Mr. W. H. Dickinson ('Med. Chir. Trans.,' vol. xxxiv. p. 1) has

shown that digitalis in such doses as from ʒss. to ℥iss. of the infusion, and ♏xx. to ♏xl. of the tincture, has a specific action on the womb; and its power of producing abortion, though not proved, is to be inferred from the facts stated.

It results from these observations on the power of drugs, that there is no one medicine that can be depended on to procure abortion in women not strongly predisposed; that, if given in doses short of those which risk the life of the mother, they would almost certainly fail; that, when they do succeed, they place the life of the mother in jeopardy, and often sacrifice it; and that, for every case in which the mother escapes, there is probably one at least in which mother and offspring both fall a sacrifice, and one in which the mother dies, the child remaining intact in the womb.

Local, or *Mechanical means*.—These consist either of *external violence*, or of *instruments introduced into the womb.*

External violence is a sufficient cause of abortion. But it would appear that unless it is such as to endanger the life of the mother, it is not likely to succeed.

In 1811 a man was executed at Stafford for the murder of his wife. She was pregnant, and he succeeded in inducing abortion by violently elbowing her in bed, rolling over her, &c.; but he also caused her death.* "A female in the last month of her pregnancy was struck on the abdomen by her husband. An extensive detachment of the placenta caused the immediate death of the fœtus, and that of the mother in fifty-one hours afterwards."†

Severe injuries not directly inflicted on the abdomen often fail to occasion abortion. Thus, Madame La Chapelle tells us of a young midwife, who was pregnant and had a narrow pelvis; and, to procure abortion and avoid the Cæsarian section, threw herself from a height. She died from her wounds, but did not miscarry. Mauriceau also gives the case of a pregnant female seven months gone, who to escape from a fire slid down from the third story, but losing her hold, fell on the stones and fractured her forearm; but there was no abortion.

The same remarks apply to the *introduction of instruments into the womb* by unskilful persons. In some instances abortion has been procured; in others, after considerable injury had been inflicted on the vagina and uterus the child was born alive; and in all of them the mother's life has been endangered or sacrificed.

Sulphuric acid has been injected into the vagina with a view

* Smith's 'Forensic Medicine,' p. 305. † Campbell, op. cit. p. 131.

of producing abortion; and occasioned violent inflammation of the parts, and adhesion of the os tincæ, with the formation of a dense membrane over it. After attempting delivery by incisions into the neck of the womb, it was found necessary to perform the Cæsarian operation—and both mother and child died.*

A case which occurred in the practice of Dr. Wagner, of Berlin, illustrates so forcibly the difficulty of procuring abortion in women not predisposed, whether by medicines or by force, that it will form a fitting conclusion to this subject.

A young woman, seven months with child, had employed savin and other drugs to produce miscarriage. As these failed, her paramour bound a strong leathern strap (the thong of a skate) tightly round her body. This too availing nothing, he (by his own confession) knelt upon her with all his weight, and trampled on her while she lay on her back. "As this also failed, he took a sharp-pointed pair of scissors, and proceeded to perforate the uterus through the vagina. Much pain and hæmorrhage ensued, but did not last long. The woman's health did not suffer in the least; and, pretty much about the regular time, a living child was brought into the world without any marks of external injury upon it."

Examination of the female.—We should be guided in such an examination by the signs already laid down at p. 62; bearing in mind that they are less strongly developed in the early than in the later months. Before two months little dependence can be placed on them.

If the female dies, we may be required to examine the body, and must be guided by the signs of delivery as at the full period, but less distinct as the period of utero-gestation is earlier.

The following is a summary of the chief points to be attended to in cases of *abortion*:—The supposed product of conception must be submitted to minute and careful examination. If a fœtus has been expelled, its age must be determined by the rules already laid down.

The reputed mother, whether alive or dead, must then be examined;—if alive, we must try to ascertain whether there was such a predisposition to abortion as to account for its having taken place, without attributing great efficacy to the means employed. With a view of determining whether or not such a predisposition exists, we must inquire into the general state of health of the mother before the abortion took place, and especially whether she has had previous abortions—and if so, whether

* Report of M. Guerin to the Académie Nationale of Paris, cited in the 'Lancet,' vol. viii. p. 38.

they occurred at or about the same period of gestation. If the female died from the means employed, we must use the same care in examining the uterus, and must observe the rules hereafter to be laid down for conducting post-mortem examinations.

Some questions of medical ethics mix themselves up with the question of abortion, as

Under what circumstances, and by what means, is it morally and legally proper to induce premature delivery? and what circumstances will justify the Cæsarian operation?

Such questions are easily answered. The medical man is clearly justified in resorting to any measure which promises to preserve the life of mother and child when both are threatened; and where one only can be preserved, the female herself may use her right of self-preservation, and choose whether her own life or that of her child shall fall a sacrifice to the means recommended.

INFANTICIDE.

There are no criminals who meet with so much sympathy as women guilty of Infanticide. This feeling, largely shared by members both of the medical and legal profession, is partly explained by the exceptional nature of the crime, and partly perhaps by the extreme harshness and cruelty of a former statute (21 Jac. I. cap. 27), which virtually visited the concealment of shame with the punishment of murder. It was under the influence of that injustice that Dr. William Hunter, in 1783, wrote his celebrated essay 'On the Uncertainty of the Signs of Murder in the Case of Bastard Children.' About a quarter of a century later (1803) an Act was passed decreeing that women accused of infanticide should be tried by the same rules of evidence as obtain in other trials for murder; but that if acquitted, they may be tried for concealment of the birth, and, if found guilty, punished by imprisonment for a term not exceeding two years.

The provisions of this statute were confirmed by an Act passed June, 1828 (9 Geo. IV. cap. 31), which also provides that it shall not be necessary to prove whether the child died before, at, or after its birth. The Consolidation Act (24 and 25 Vict. cap. 100) adopts and extends these provisions.*

* § 60. *Concealing the birth of a child*, is to the following effect:—"If any woman shall be delivered of a child, every person who shall, by any secret disposition of the dead body of the said child, whether such child died before, at, or after its birth, endeavour to conceal the birth thereof, shall be guilty of a misdemeanour, and being convicted thereof shall be liable, at the discretion of the Court, to be imprisoned for any term not exceeding two years, with or without hard labour: provided that if any person tried for the murder of any

Questions of infanticide are necessarily more complicated than those of homicide in general; for, before inquiring into the means by which a child has come by its death, it is necessary to show that it was born alive. The medical man may, moreover, be required to examine the suspected mother, in order to determine whether or not she has been recently delivered.

Two classes of questions, then, may be raised in cases of infanticide: the one relating to the child; the other to the mother.

Those relating to the child are the following:—

1. What is the degree of maturity of the child?
2. Was the child born alive?
3. If born alive, how long did it survive its birth?
4. How long has the child been dead?
5. What was the cause of death?

I. MATURITY OF THE CHILD.

This question will be answered by employing the data contained in the introduction to this Chapter, viz., the length and weight, the position of the centre of the body, the proportional development of the several parts, the growth of the hair and nails, the condition of the skin, the presence or absence of the membrana pupillaris; in the male, the descent or non-descent of the testicles, &c.*

II. WAS THE CHILD BORN ALIVE?

The legal meaning of the term *born alive*. It has been decided in more than one case, that to constitute live-birth the child must be alive after the whole body has been brought into the world; that it must have an independent circulation; but that an independent circulation does not imply the severance of the umbilical cord.

In examining the body of a child with a view to determine whether it was born alive, the chief point to be attended to is the state of the lungs. If we discover in these organs signs of respiration, there is a probability in favour of live-birth; but if we do not, there is an equally strong probability that the child was still-born. But, in the absence of signs of respiration, proof

child shall be acquitted thereof, it shall be lawful for the jury, by whose verdict such person shall be acquitted, to find, in case it shall so appear in evidence, that the child had recently been born, and that such person did, by some secret disposition of the dead body of such child, endeavour to conceal the birth thereof, and thereupon the Court may pass such sentence as if such person had been convicted upon an indictment for the concealment of the birth."

* See ante, p. 66 et seq.

may still be forthcoming that a child has or has not been born alive. Hence the present inquiry consists of two parts. 1. The evidence of live-birth, independent of, and prior to, respiration. 2. The evidence of live-birth subsequent to, and deduced from, respiration.

The evidence of live-birth prior to respiration is either negative or positive,—negative when we discover signs of previous death within the womb; and positive when we find injuries on the body of the child which must have been inflicted while the blood was still circulating, and of such extent and severity that they could not have happened accidentally or been inflicted *during* the birth.

Intra-uterine maceration.—The appearances presented by a child which has died in the womb, and has there undergone maceration, are the following:—The body is shrunken and flaccid in every part, the chest and abdomen flattened, the ribs distinctly visible through the skin, the ilia prominent. The head is soft and yielding, so that it falls flat in whatever position it may be placed. The cuticle is more or less extensively detached, and easily separates from the true skin. On the hands and feet it is white, thickened, and wrinkled, as if from the application of a poultice. The true skin itself is more or less extensively discoloured. The abdomen, which first exhibits the change of colour, presents a mottled appearance, blending a rose and ash colour. Elsewhere the skin assumes a brownish red, without any admixture of green. The parts of generation have a deep-red colour, as have also, in a less degree, the head and face. The umbilical cord is straight and flaccid. The whole surface of the skin is covered with a soapy fluid, so that the body, when handled, slips from the grasp. On cutting into the cellular membrane it is found to be infiltrated with serum reddened by the colouring matter of the blood, and to contain in parts, especially in the scalp, a substance aptly compared to gooseberry jelly. The periosteum is readily detached from the bones of the cranium, which move easily one upon the other. The cavities are filled with an abundant bloody serum, and the viscera, which are tinged throughout of a reddish-brown colour, have their minute structure very distinctly displayed.

These appearances are more or less strongly marked, as the child has lain a longer or shorter time dead in the womb. They are quite distinct from the effects of putrefaction, whether in air or water, and the putrefactive odour is entirely wanting. When fully developed it is impossible to mistake them for those due to any other cause; but if the child's death occurred only a short

time before its expulsion from the womb they would not be present. The annexed engraving shows the appearance of the body of a fœtus in which intra-uterine maceration had proceeded so far as to cause extensive separation of the cuticle. The colour of the true skin is a deep rosy red on the body, with a deeper tint on the head, and a still stronger colour in the parts of generation.

Fig. 15.

The single case in which, anterior to, and independent of, respiration, we may state that a child was born alive, is, when we find marks of violence on the body so severe that they could not have been inflicted during the birth, and attended with hæmorrhage so considerable that it could only have occurred while the blood was still circulating. Thus Devergie relates a case of an infant that had not breathed, yet was proved to have been murdered, by extensive wounds and marks of great violence on the head, with copious effusion of blood.* To justify a positive opinion, the loss of blood must be large; for a severe wound inflicted on a plethoric infant after the circulation had ceased, might be attended with considerable hæmorrhage.

There are two cases, then, in which, independent of, and anterior to, respiration, we may decide the question, "was the child born alive?" negatively, when we find the marks of intra-uterine maceration; affirmatively, when we discover injuries so extensive and severe, that they must have been inflicted after the birth, and while the blood was still circulating.

* 'Annales d'Hygiène,' May, 1837.

But evidence of live-birth before respiration is rarely obtainable, for very few children in whom the blood is still circulating are born without breathing, at least imperfectly.

In the great majority of cases, then, the evidence of live-birth must be sought for in the lungs, proof of respiration being the first link in the chain of evidence that the child was born alive. We must first show that respiration has taken place, and then that the child breathed after the birth; for it may have breathed during the birth and yet have perished before complete delivery, which constitutes live birth.

HAS RESPIRATION TAKEN PLACE?

The best evidence of respiration is the change it produces in the external appearance of the lungs; and, were it not that inflation gives rise to the same change, mere inspection would supersede all other tests. As it is, it serves to establish the alternative of respiration or inflation when all other means fail.

Lungs which have neither respired nor been inflated, are of a uniform texture throughout, and resemble in colour and consistence the adult liver. Their surface is marked by slight furrows, which obscurely denote the division of the lobules. When they are full of blood, these are scarcely visible; but when they are comparatively empty, they are more distinct, and are still more strongly marked in the lungs of the fœtus which has undergone intra-uterine maceration. The lungs are also sometimes found studded with small melanotic spots, often circular in form.

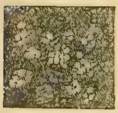
The effect of respiration or inflation varies according to its degree. The smallest quantity of air serves to develop some of the cells on the surface of the lungs; and these form the best proof of the admission of air in one of these two ways. The right lung, and especially the edges and concave surface of its upper lobe, admit air most readily: it is here, therefore, that the first effects of inflation or respiration must be looked for.

The air-cells thus developed present a highly characteristic appearance. If the lungs are fresh and full of blood, they assume the form of brilliant vermilion spots; if they contain less blood, or are examined some days after death, the spots are of a lighter colour; and in children who have survived their birth some days, they have very nearly the hue of the healthy adult lung.

The form and arrangement of the cells are not less characteristic than their colour: they are angular, are not perceptibly raised, and are obviously situated in the substance, though near

the surface, of the lung. The grouping of the cells is generally irregular, but occasionally they are found in regular and symmetrical groups of four. Their ordinary appearance and grouping is represented in the annexed wood-cut taken from a coloured drawing of lungs in which respiration had been imperfectly set up.

Fig. 16.



I have once seen the air-cells as a group of small globules, like millet seeds, arranged closely side by side, on the same level.

The only appearances on the surface of the lungs with which these developed air-cells might possibly be confounded, are, 1, the small melanotic spots already mentioned; 2, small spots of blood; and 3, air-bubbles, the product of putrefaction. The first two appearances may be at once distinguished by the roundness of the spots, the absence of anything resembling a developed texture, and their characteristic colour, the melanotic spots being black, and the spots of blood of the colour of extravasated blood.

The appearances produced by putrefaction are quite as characteristic. The air collects on the surface, and between the lobes of the lungs, either in detached projecting globules, the size of peas, or as a string of small vesicles, like a fine mercurial injection beneath tissue-paper. It is evidently contained in the cellular membrane connecting the pleura with the surface of the lung, and its true situation is often pointed out by a small globule seated on a larger one. If these appearances were not sufficient to distinguish air, the product of putrefaction, from air in the air-cells, it would suffice to pass the finger over the surface of the lung. The air follows the pressure of the finger, and is dispersed, and a little stronger pressure effaces the bubbles, and even breaks down the larger globules. No amount of pressure so applied will force the air out of the air-cells, or in any way alter their appearance.

Some authors, as will be presently more fully stated, have spoken of an emphysema of the fœtal lungs, as giving rise to some difficulty in applying the hydrostatic test; but it will be shown that this so-called emphysema is merely an incipient process of putrefaction, causing the same appearances, and admitting of the same ready discrimination. The subjoined engraving (fig. 17) is as faithful a representation, on a somewhat enlarged scale, as it is possible to give, without colour, of the appearances just described. With the exception of the large air-bubbles, taken from another subject, they were all present on a limited space of the same lung. The air-cells are recognised by their peculiar shape

and grouping; the rounded dark spots are melanotic, the fainter spots are effused blood; the string of small light round dots, and the large circular spots, are air-bubbles.

Fig. 17.

That change of colour which takes place on the surface of fresh fœtal lungs from the contact of air must not be confounded with the developed air-cells. The change of colour is the same, but the mere contact of air in no way alters their texture.

The appearance of the developed air-cells is, therefore, characteristic; it furnishes undeniable proof either of respiration or of inflation; and it is the only lung-test to which no serious objection can be offered.

Considered as a sign of the admission of air into the lungs in one of these two ways, it is as delicate as it is simple; for it detects a quantity of air too small to affect the specific gravity either of the whole lung, or of the parts into which it has been introduced. I have repeatedly detected at a glance, in the superficial air-cells, a quantity of air insufficient to render the smallest fragment of lung buoyant; and I have never found these signs of respiration absent in any case in which a child was stated to have breathed, though for the shortest space of time. In one case in which the child was reported to have given only three gasps, the effect of respiration was obvious, at a glance, in the bright vermilion-coloured groups of developed air-cells scattered over the surface of the right lung. This sign, therefore, succeeds where the hydrostatic test fails.

If a different appearance were produced in the air-cells by respiration and inflation respectively, and we could infallibly distinguish the one from the other, there would be no need of any other lung-test.

Devergie,* after stating, correctly enough, that a careful examination had enabled him to distinguish, *à priori*, and without any other research, lungs belonging to a still-born infant from those of an infant which had breathed; and also to determine whether the air had dilated all parts of the lungs, or merely certain portions, adds, that "in *many* cases he could determine whether the distension of the lungs with air was the effect of re-

† 'Médecine Légale,' art. Infanticide.

spiration or of insufflation." In the case of respired air he states that there is a minute injection of capillary vessels on the surface of the air-cells, which does not take place in inflation. This distinction may be well founded, but as it deals with very minute parts, and, according to the author's own statement, is to be relied on only in *many*, but not in *all* cases, it may be set down as unfit for medico-legal use. I have not myself observed such a difference between the effects of inflation and respiration as to pretend to be able in this way to distinguish the one from the other.

Developed air-cells, then, form the best, and only necessary proof, of the admission of air into the lungs; and they are to be found in every case of respiration or inflation, however limited in extent, or slight in degree.* The number of the cells is, moreover, a measure of the extent to which these processes have been carried. When respiration is complete, the lungs present the same spongy, crepitant character as in the adult, and differ from them only in having a more rosy colour.

Before proceeding to the other lung-tests, we must premise that respiration is not a sudden, but a gradual process; that it is rarely, perhaps never, completed in a few respirations; that it very often remains incomplete and partial after many hours, days, or even weeks; and that in some grown-up persons portions of lung are even believed to retain their fœtal state. In the great majority of cases of infanticide, therefore, we shall have to deal with lungs in which respiration has been very incompletely set up. Hence the importance of a sign which stands us in stead where, as will be presently shown, every other test may fail.

But the admission of air into the cells of the lungs is not the only effect of respiration. As a general rule it is attended by an increased afflux of blood, adding to the weight of the lungs, both when taken by themselves, and when compared with the weight of the body to which they belong. This increase of weight, absolute and relative, has been made the basis of two lung-tests.

Absolute Weight of the Lungs.—This test of respiration rests on the supposition that the arteries and veins of lungs which have not respired, are empty, and in a state of collapse, while after respiration they become more or less filled with blood. That this statement of Foderé, since corrected by Orfila and Devergie, is most erroneous, I have had many opportunities of proving; for I have found lungs which had breathed almost destitute of blood;

* It is strange that this simple sign of respiration should have been so often overlooked. Cruveilhier, in his 'Morbid Anatomy,' depicts the bright vermilion air-cells as a disease of the fœtal lungs.

and others that had never admitted air, or presented only a few groups of developed cells, gorged with blood in every part.

The early estimates of weight were in accordance with these mistaken assumptions. The lungs of mature children before respiration were stated to weigh one ounce, or 480 grains; after respiration two ounces, or 960 grains. How remote these estimates were from the truth, the following averages, founded on upwards of 400 observations on mature children, will show :— Still-born, 874 grains; children who had survived their birth one month or less, 1072 grains. The observed weight, therefore, in still-born children is nearly double the rude estimate of authors, and the increase after respiration, instead of being equal to the original weight, is less than one-fourth. These averages differ too little to admit of application in a court of law; the extreme figures are still more conclusive, as the comparison made in the following table will show.*

Before Respiration.	After Respiration.	Before Respiration.	After Respiration.
510	510	694	—
520	—	703	—
550	546	713	726
—	562	744	746
586	590	—	774
630 (two)	—	—	861
632	—	—	920
640	—	1054	1000
647	—	—	1173
658	—	—	1189
666	—	—	1203
683	675	1480	—
687	—	1950†	—

	Before.	After.
Maximum . .	1950	1203
Minimum . .	510	510
Mean . . .	769	820

From this table it appears that out of 34 cases, there is not one in which we could have stated, by means of this test alone, that respiration had, or had not, taken place; while, in two instances, the great weight of the lungs would have led us to infer respiration in still-born infants.

* For the particulars of these observations, which are all taken from English sources, see 'Lancet,' Oct. 1, 1842. The case marked † has been subsequently added. It is given on the authority of Dr. Taylor.

As in most cases of alleged infanticide the lungs, if the child has breathed at all, are found to contain but little air, it is important to determine the effect of imperfect respiration in increasing their weight. The following are the average figures from a large number of facts:—Still-born, 874 grains; imperfect respiration, 988; perfect respiration, 1195. So that the effect of imperfect respiration is to increase the weight of the lungs by about 100 grains, or one-eighth of their original weight.

Different durations of respiration affect the weight of the lungs as follows:—Still-born, 874 grains; less than one hour, 918; twelve hours, 853; one day, 1000; one month and less, 1072 grains. Hence one hour's respiration adds less than .50 grains to the weight of the lungs, which is increased by only 126 grains when respiration has lasted one day.

If additional evidence were required of the uselessness of this test, it might be found in a comparison of the weight of the lungs in two children born alive with the same weight of body. In the one the lungs weighed 494, in the other 1544 grains, or more than three-fold.

The difference, then, between the absolute weight of the lungs before and after respiration, and especially after imperfect respiration, or respiration lasting only for a short time, is much too slight to be used as a test; and the inference drawn from a comparison of average weights is fully confirmed by that of the extremes.

The absolute weight of the lungs has been recommended as a means of distinguishing respiration from inflation. But this it cannot do; for it is obvious that inflated lungs are, as to the blood which they contain, in the exact condition of fœtal lungs.

Ratio of Lungs to Body.—Ploucquet's Test.—Before entering on an examination of this test we must premise, that the bodies of still-born infants are heavier by about one-third than the bodies of those born alive; that the male is heavier than the female; that the proportion of the lungs to the body decreases as the weight of the body increases; and that the weight of the lungs is extremely variable even when compared to that of the body.

This test is a good example of the futility of conclusions drawn from a small number of facts. Ploucquet, making use of three facts, only two of which were strictly comparable, happened to obtain the proportion before respiration, of 1 to 70; after respiration, of 1 to 35. But that these figures are very far removed from the true proportions the following averages drawn from more than 400 observations on mature children will show—

Still-born 1:57, instead of 1:70; children surviving one month or less 1:38 instead of 1:35. The extremes, which, as before observed, are the values required for practical purposes, are shown in the following table :—

Before Respiration.	After Respiration.	Before Respiration.	After Respiration.
1:91	—	1:54	1:55
1:82	—	1:51 (two)	1:52
1:74	—	1:49	1:49
1:71 (two)	—	—	1:48
1:70	—	—	1:46
1:67	1:65	1:45	1:45
1:61	1:61	—	1:44 (two)
1:60	—	—	1:41
1:59	1:59	—	1:39
1:57 (three)	1:56	1:21	

	Before.	After.
Maximum . .	1:21	1:39
Minimum . .	1:91	1:65
Mean . . .	1:60	1:50

The results of this table differ somewhat from those obtained in the case of the absolute weight of the lungs; for in 7 cases out of 33 there is a probability, derived from the low ratio, that respiration had not taken place; but, on the other hand, there is one case in which, relying on the low ratio of 1:21, we should have mistaken a still-born child for one that had breathed.

The following are the mean proportions after different durations of respiration:—Still-born, 1:57; less than one hour, 1:51; 12 hours, 1:53; 1 day, 1:48; 1 month, or less, 1:38.

The difference between these several proportions is certainly much too small to justify the use of the test in cases of imperfect respiration, in which alone it would be required.

If further proof were needed of the futility of this test, it might be found by a simple comparison. The weight of the body being in each of two children born alive 32,436 grains, the lungs bore to the body in the one the proportion of 1 to 21, in the other of 1 to 66; the first ratio being more than three times as great as the second. The same remarks, too, apply to this test as to the absolute weight of the lungs. Simple inspection would render it superfluous even if it were useful; and it cannot serve to distinguish inflation from respiration.

Both the static lung-tests should, therefore, be allowed to fall into disuse as alike unsafe and unnecessary.

The Hydrostatic Test.—This test is very interesting from the many controversies to which it has given rise, the important purpose to which it was applied, and the high value formerly assigned to it.

That this test may be understood, it must be premised, that though, when first proposed, it was erroneously considered a test of live or still-birth, it is merely a test of respiration. It must also be premised that the test has undergone several modifications since it was first proposed towards the end of the seventeenth century. Originally, and till a comparatively recent period, it consisted in placing the lungs, with or without the heart attached, in a vessel of water of the temperature of about 60°. This rough test was first modified to the extent of dividing the lungs into several pieces and experimenting with them as with the entire lungs. The test, as now performed, consists in first immersing the several pieces of the lungs in water, and then applying to them the subsidiary test of pressure. It will be presently seen that the objections to the hydrostatic test apply to it chiefly as originally performed; and that this addition of pressure removes at least one objection, though it leaves others in full force, and opens an important inquiry as to the distinction between the effects of respiration and inflation.

In examining the hydrostatic test, it will be convenient to consider first the value of the test as originally performed, including the addition subsequently made of dividing the lungs into several portions, but without submitting them to pressure; and with the distinct understanding that it can in no case be a test of live birth, but only of respiration. A supporter of the test thus applied would assert on its behalf, that, if the lungs, whether entire or divided into portions, when placed in a vessel of water sink to the bottom, respiration has not taken place.

To this assertion there are two objections. 1. That respiration may have taken place, and yet both the entire lungs, and the several parts into which they have been divided, may sink in consequence of disease. 2. That respiration may have taken place, but to so limited an extent, or in so imperfect a manner, that the lungs and every part of them, though perfectly healthy, and containing only the ordinary quantity of blood, may nevertheless sink.

In examining the first objection, it must be borne in mind that disease may exist before respiration or supervene after it. Now as a disease existing before birth would not affect every part of the lungs, there is nothing to prevent the healthy portions from receiving air, and these would float, provided the quantity of air admitted into them were sufficient. If, again, the disease supervene after

respiration, it is not probable (though a case of double pneumonia fatal the eighth day, in which both lungs "sank completely even to their smallest particles," is recorded by Casper) that it would proceed to such an extent as to consolidate the whole of both lungs; so that some portions would be found to float. Whether, therefore, the disease occurred before or after respiration, the cases must be extremely rare in which it would constitute a valid objection.

In the case of partial disease of the lungs, the first objection just stated merges in the second; for if lungs healthy in all their parts may respire without becoming buoyant, it follows that the healthy portions of diseased lungs may receive air in quantities equally inadequate to render them buoyant.

This leads to the second objection, viz.:—That respiration may have taken place, but to so limited an extent, or in so imperfect a manner, that the lungs and every part of them, though perfectly healthy, and containing only the usual quantity of blood, may sink. A single case will suffice to prove this objection valid. In a female twin, weighing little short of five pounds and probably nearly mature, "The substance of the lungs was healthy, of a deep Modena-red colour, with here and there patches of a somewhat lighter hue." There was no crepitation under the knife, nor was there any congestion.* Both lungs, when placed in water, sank with equal rapidity; and every one of the fifteen pieces into which each lung was divided sank rapidly to the bottom: and on compression below the surface no bubbles of air escaped. This child had survived its birth twenty-four hours.

This case is by no means unique; for similar instances have been reported by Bernt, Remer, Orfila, Daniel, Schenk, and Osiander.† Billard, meeting with some of these cases, was led into the strange error of supposing, that children may survive their birth for hours, and even days, without breathing.‡ I have myself repeatedly examined lungs in which respiration had been very imperfectly set up in several parts of one or both, and yet only one or two of these parts floated when placed in water. But I have not met with any instance in which every portion of both lungs sank.

The objection, then, to the statement that the sinking of the lungs, whether entire or divided, is a proof that respiration has not taken place, is valid as applied to the hydrostatic test in its original form; and it of course applies equally to lungs healthy in

* Dr. Taylor in 'Guy's Hospital Reports,' No. v. case 4.
† See Dr. Taylor's essay just quoted.
‡ 'Maladies des Enfans,' title Viabilité.

all their parts, and to those which have only portions of their structure free from disease.

Let us now suppose that the entire lungs, or any one of the parts into which they have been divided, float in water; and that this buoyancy of the whole lung, or of its parts, is alleged as proof that respiration has taken place. This assertion would be met by three distinct objections. The buoyancy may be due, not to respiration, but 1. to Emphysema; 2. to Putrefaction; or, 3. to Inflation. The first objection, that the lungs may float in consequence of emphysema, is easily disposed of. The term emphysema, in its usual acceptation, means an enlargement or rupture of the air-cells caused by air introduced through the air-tubes in the process of respiration, or by inflation. Now, air so introduced into the lungs will expand the air-cells so as to furnish, independent of the emphysema itself, distinct proof that the child has breathed. On the other hand, if the emphysema were caused by inflation, the first objection would become identical with the third. But the emphysema urged as an objection to the hydrostatic test, is of a different kind, and is attributed to air generated by some peculiar action of the lung tissues. Dr. Cummin* says: "It sometimes happens that infants suffer violence in the birth; the labour, perhaps, being tedious, and the mother malformed. The sides of the chest may be so pressed against the substance of the lungs as to do those organs injury; they become inflamed and puffy, containing air in large vesicles on their surface, and this is what some authors call emphysema." Lécieux also states that in extracting an infant by the feet, he often found that a part of the lungs floated, though the child had certainly not breathed, and even died in the course of the delivery. He could not attribute this buoyancy of the lungs to putrefaction, because the infant was fresh, and he examined the body soon after extraction; but as we sometimes see a wound or bruise, especially on the head, accompanied by an emphysematous swelling, it appeared to him that, during the extraction of the fœtus, the lungs may suffer a sort of contusion; that blood is effused into their tissue, which gives rise to the formation of some bubbles of air, and the consequent buoyancy of a part of the lungs. This explanation appeared to him the more probable, inasmuch as the lungs had a brownish violet tint.†

That we need not resort to this explanation the following fact will prove:—

* 'The Proofs of Infanticide Considered,' by William Cummin, M.D., p. 61.

† Lécieux: 'Considérations Médico-légales sur l'Infanticide.'

In the winter of 1840, I examined the body of a mature still-born fœtus, within forty-eight hours of its extraction by instruments. There was not the slightest trace of putrefaction in the lungs or in any other part of the body; no change of colour, no softening of tissues, no putrefactive odour, and, with the exception of a vesicle the size of a pea on the surface of one of the lungs, no formation of gas. The lungs, which were gorged with blood, were extracted, put into a gallipot, and carried in the pocket about two hours; at the end of which time their whole surface was found studded with vesicles, some as large as a pea, others smaller than a pin's head.

Here, then, in the course of two hours a very large quantity of gas was developed, though the lungs had certainly undergone no injury in the birth, and no single sign of putrefaction could be detected.*

This incipient putrefaction, for it is nothing less, is not limited to the lungs, but occurs in effusions of blood on the brain (of which I have seen two examples) and in parts of the body containing an unusual quantity of blood. When it occurs in the lungs they are usually congested, or the seat of pulmonary apoplexy which is apt to occur in tedious labours, or in infants extracted by instruments.

This so-called emphysema being, therefore, nothing more than an incipient process of putrefaction, the first objection to the floating of the lungs as proof of respiration merges in the second; and instead of three objections we have two: 1. The formation of air in the cellular tissue in consequence of incipient or advanced putrefaction; and 2. Inflation.

1. *Putrefaction.*—The possibility of the lungs floating from putrefaction was formerly questioned, but without reason.

Experiments which I made in the winter of 1839, illustrate the origin of the opinion that putrefaction will not cause the lungs to float. The lungs of some still-born children, when placed in water,

* On referring to Casper's Handbook (vol. iii. p. 68) it will be seen that he only wanted such a fact as this to complete his exposure of the weakness of the grounds on which this objection of emphysema has been made to rest. His criticisms certainly warrant the statement "that not one single well-observed and incontestible case of emphysema developing itself spontaneously within the lungs of a fœtus, born without artificial assistance, is known, and it is not, therefore, permissible in forensic practice, to attribute the buoyancy of the lungs of new-born children, brought forth in secrecy and without artificial assistance, to this cause." The words "without artificial assistance," introduced to meet a case by Hecker, to which Casper attaches undue importance, would have been rendered unnecessary by a knowledge of the *experimentum crucis* described above, and now nearly 30 years old.

as soon as they began to give out a putrefactive odour, gradually rose to the surface, remained there several days, and then slowly sank to the bottom. In other instances, large air-vesicles were formed on the surface of the lungs, but not in sufficient number to render them buoyant; while in others, though the lungs gave out a strong putrefactive odour, there were no air-vesicles, and no tendency to rise to the surface, nor did they ever float either in the water in which they had stood, or in fresh water.

There is, therefore, no doubt that gases developed in the various stages of putrefaction may cause lungs which have not breathed to float. This objection to the hydrostatic test, as originally performed, is therefore valid.

2. *Inflation.*—The objection that the lungs may be rendered buoyant by inflation, is also valid, as the possibility of so inflating the lungs as to cause them to float is universally admitted.

It follows, then, that to the Hydrostatic Test, as originally applied, and used merely as a test of respiration, there are four valid objections; two to the sinking as a sign that respiration has not taken place, and two to the floating as a proof that it has: to the sinking of the lungs as a proof of non-respiration, disease, and imperfect respiration; to the floating of the lungs as a proof of respiration, putrefaction (in its several degrees and stages) and inflation.

Such is the value of the hydrostatic test, in the sense in which the term was used up to the time of the introduction of pressure as an auxiliary.

The Hydrostatic Test modified by Pressure.—The mode of applying pressure is not material, provided it be not carried to the extent of destroying the texture of the lung. For some purposes the pressure of the finger and thumb under water is sufficient; but if stronger pressure be required, the fragment of lung may be placed in a clean cloth, of which the ends are twisted opposite ways, by the aid of an assistant. The pressure will rarely be required to be carried beyond this point, though in experiments presently to be described, the fragments of lung were submitted to strong pressure by treading the cloth which contained them under foot.

A supporter of the hydrostatic test, in this its modern signification, would assert, on its behalf, that if the lungs, both entire and divided, when placed in water, sink, both before and after being submitted to pressure, that respiration has not taken place. The objections to this assertion are the same which apply to the earlier test, viz., disease and imperfect respiration, with this

difference, however, that portions of lung containing a large quantity of blood and too little air to render them buoyant, might possibly float after a portion of the blood had been forced out by the pressure. Hence the sinking of the lungs after pressure affords a stronger reason for supposing that respiration has not taken place.

But supposing the several portions of the lungs to float both before and after pressure; and it is asserted that this buoyancy of the lung is a proof of respiration, do the two objections urged with success against the earlier test, viz., putrefaction and inflation, hold good against this modern test also?

The objection on the score of putrefaction falls at once to the ground; for the mere pressure of the fingers expels the air generated by putrefaction, and causes the lungs to sink. It only remains, therefore, to consider the objection, that inflation may cause the lungs to float.

That air so introduced into the lungs will render them buoyant, there can be no doubt; but whether pressure will distinguish the buoyancy due to respiration from that due to inflation is a question that demands very careful consideration.

The addition of pressure to the old hydrostatic test was proposed by Béclard, and introduced into practice in this country by Dr. Taylor,* and Mr. Jennings,† both of whom employed it as a diagnostic mark. The former concludes from repeated experiments, "that air, introduced by artificial inflation, may, under all circumstances, be expelled by compression, if the experiment be properly performed, and the pressure continued a sufficient length of time."‡ Mr. Jennings states, that "air introduced into the lungs, by artificial inflation, may be expelled by pressure, so that the lungs will sink in water," and on the other hand, that "after respiration, the air cannot be expelled from the lungs without completely breaking down the structure of every part of the organ. Any part, however small, not thus broken down, will continue to float."

The value of this test can be decided only by an appeal to facts. Now it is admitted by Dr. Taylor, on the authority of Case III. in the Essay already cited,§ "that air, from respiration," (imperfect respiration,) "may, by very moderate pressure, be forced out from divided portions of the organs;" and, on the

* 'London Med. and Phys. Journal,' Nov. 1832, and Jan. and May, 1833.

† 'Trans. of Prov. Med. and Surg. Association for 1833.'

‡ 'Guy's Hospital Reports,' No. v.

§ The child survived six hours, and breathed very imperfectly.

authority of Case II., "that there are no satisfactory means of distinguishing artificial inflation from feeble respiration." Schmitt also reports a case in which the middle lobe of the right lung alone floated, and that imperfectly, but sank again when forcibly compressed. The child had lived twenty-four hours, and the lungs had not been inflated.*

This test, then, does not distinguish imperfect respiration from imperfect inflation. On the other hand, some experiments which I made in the year 1841 prove that lungs completely distended by inflation cannot be made to sink by pressure short of that which destroys the texture of the lung; and that lungs so distended with air differ from those that have breathed completely only by requiring somewhat more pressure to make them sink.

As this statement is important, an account of one of these experiments, from notes made at the time, is subjoined.

"I took the lungs of a child two months old who had died of marasmus, and the lungs of a fœtus, still-born, at eight months. I inflated the fœtal lungs completely, and in doing so ruptured the air-cells, and produced emphysema over the entire surface, so that when I ceased to inflate them the lungs rapidly collapsed. I then took one lobe from the lung of either body, and, placing them together in a cloth, submitted them, by means of an assistant, to strong pressure. Both portions still retained their buoyancy. I next stood on the cloth, and repeatedly stamped on it, but still both floated, though their structure was almost destroyed. I then took a portion from the lungs of both children, distinguishing the lung which had breathed by the darker colour of its central portion, placed them both together in the same cloth, and proceeded as before. After applying pressure by twisting the cloth strongly, both pieces continued to float; they retained their buoyancy even after they were trodden on, and it was not till they were pounded with the heel, and their structure thoroughly broken up, that the inflated portion sank: the portion of the lungs which had breathed still floated, though imperfectly. On pounding this portion of lung a second time, this likewise sank. A second and a third experiment led to the same result, the inflated portion of lung sinking after a *less* degree of pressure than the portion which had breathed, but the structure being in both portions broken up before their buoyancy was destroyed." Another series of experiments was attended with the same result.

If, in these experiments, pressure, short of that required to

* Schmitt, 'Neue Versuche,' &c., 93rd observation, p. 217.

break down the structure of the lung, had caused the inflated portions to sink, while it was necessary to destroy the structure of the portions which had breathed before they could be made to sink, we could understand how *pressure* might become a means of diagnosis: but as the only difference is the degree in which the structure is broken up, and as, in any given case, we shall have to examine a portion of lung separately, and not side by side with one which we can take as a standard of comparison, it is obvious that this test of pressure is not applicable to medico-legal purposes.

It has been objected to these experiments that, having been made on lungs inflated out of the body, their results do not admit of application to lungs inflated within the body. This objection, of which it is difficult to see the validity, has happily been obviated by experiments upon lungs successfully inflated within the body. Two such cases, of which one was reported in the 'Medical Times,' Nov. 30, 1844, were communicated to the author by Dr. Henry Browne, of Manchester, and two similar cases by Dr. F. J. Hensley, were published in the 'Medical Times,' Feb. 8, 1845. All these children were still-born, and the lungs were extensively inflated; but they could not be made to sink by pressure till their structure was broken up.*

The only objections, then, to the hydrostatic test, coupled with such pressure as may suffice to dispel the products of putrefaction, are three:—1. The lungs may sink, and yet the child have breathed, inasmuch as respiration may have been too imperfect to render any part of them buoyant. 2. The lungs may sink, though respiration have taken place, in consequence of disease. 3. The lungs may float, and yet the child not have breathed, in consequence of inflation.

The following additional tests of respiration have been proposed.

Changes in Size and Shape of Chest.—The chest before respiration is stated to be small, narrow, and flattened; after respiration to be larger, and rounder. This test is not wanted in cases of complete respiration, while in imperfect respiration the

* I am happy to be able to confirm this statement made more than a quarter of a century ago by the high authority of Casper. He says: "It is quite incorrect to suppose, as has been done, that the air can be easily *forced by compression* out of lungs artificially inflated, but not out of those which have respired, or, at least, that it is more easy to do so in the former case than in the latter. Both of these ideas are perfectly erroneous, as I have been taught by innumerable experiments, renewed every session in the course of my lectures. The air contained in the pulmonary cells, in whichever of these modes it has been introduced, can never again be expelled, even by the employment of the utmost violence, as by standing with the weight of the whole body upon a piece of lung, &c.; and the portion of lung thus forcibly compressed, floats almost as well after its compression as before it."—Handbook, vol. iii. p. 67.

presumed changes do not occur. It is needless in the one case and useless in the other.

Change in Position of Diaphragm.—The diaphragm, before respiration, is stated to be arched and to rise high in the chest; after respiration, to be flattened and depressed. This sign is open to the same objection as the foregoing.

Increased Volume of the Lungs.—The lungs are stated to be more bulky after respiration; this increased size being due partly to afflux of blood, but mainly to admission of air. This test is condemned by what has been already said of the static lung-tests. It also is needless when respiration is perfect or extensive, and useless when imperfect.

Altered Position of the Lungs.—Before respiration the lungs lie far back in the chest, leaving the thymus and pericardium uncovered, and presenting sharp edges; after respiration they project forwards, seem to fill the chest, nearly cover the thymus and pericardium, and have their edges rounded. This is a description of fœtal lungs and of those that have fully respired; but it is inapplicable to cases of imperfect respiration; for, in all these points fœtal lungs closely resemble those that have breathed imperfectly.

Altered Consistence of the Lungs.—Before respiration the lungs are dense as liver; after respiration, spongy and crepitous. When they are spongy and crepitous, they have, of course, received air; but that air may have been either inflated or breathed. In imperfect respiration, the change in the lungs does not extend beyond the limits of the developed air-cells.

Weight of Liver compared with Weight of Body.—After respiration part of the blood which had circulated through the liver is diverted to the lungs. The liver, therefore, loses weight. Bernt, of Vienna, availed himself of this fact to encumber the subject of infanticide with another useless test; and Orfila took the needless pains to submit it to experiment. All the objections already advanced against the static lung-tests, and all that might be urged against any test whatever, apply to this.

To all the foregoing tests, then, there is one simple objection,—when respiration is complete they are needless, and, when imperfect, useless; and they do not distinguish inflation from respiration, which is the only information not obtained by the first glance at the surface of the lungs.

The refinements of balances and graduated jars, with which some German authors have tried to encumber the hydrostatic test, may be safely consigned to oblivion.

A careful examination of the lungs themselves is the best, and

only necessary means of determining whether or not they have received air through the air-passages. If the air-cells are developed, it can only be by respiration or inflation, and the number of cells so developed is the best measure of the extent to which those processes have been carried. The eye will detect these signs of the admission of air into the lungs where the quantity is too small to render any portion of their texture buoyant.

The practical directions for determining the question of respiration are, therefore, very simple. Proceed at once to extract the lungs, taking care not to injure their texture, or that of the surrounding organs: examine their surface, and if it is of a uniform colour, and the substance of a uniform firm texture like that of the adult liver, respiration has not taken place; but if the surface is mottled with spots of a bright vermilion, or of a rose colour, and these spots contain developed air-cells, then respiration or inflation has taken place.

It appears, then, that the only difficulty we encounter in ascertaining whether a new-born child has, or has not, breathed arises out of the resemblance of the effects of inflation and respiration. This difficulty, though it cannot be overcome by any lung-test, may be materially lessened by some very obvious considerations.

It is now generally admitted that the lungs of an infant may be inflated through the mouth, without having recourse to any instrument. All that is needed is to secure the nostrils, to force the larynx back on the œsophagus, and to imitate the movements of respiration by alternately compressing and releasing the chest. Four instances of such successful inflation are referred to at p. 97 of this work. Schmitt succeeded in more than one instance* in completely inflating the lungs in this way: in two so perfectly, "that not even a single point was to be found in either lung into which the air had not penetrated."† Such complete inflation is not readily effected even out of the body; for I have repeatedly removed the lungs, and inflated them by the blowpipe, and in no case have I been able to expand their entire texture without rupturing some of the superficial air-cells. It is not easy, therefore, even for an instructed and skilful person, to effect a complete expansion of the lungs; and it may be safely affirmed that such complete inflation could not be practised by an unskilful one. If, then, it were urged on a trial for infanticide, that the mother had tried to save the life of her child

* Op. cit. Experiments lxxx. and xcviii., also x. xliii. and xlix. Elsässer, as quoted by Casper, seems to have been far from successful in his attempts to inflate the lungs without opening chest or abdomen.

† Page 189.

by inflating its lungs (for the supposition that this might be done by a malicious person in order to criminate the mother is simply absurd), and it appeared in evidence that the lungs were completely expanded, the objection must fall to the ground. But even if the lungs were found very imperfectly distended, it would admit of grave doubt whether even this could be effected by an uninstructed and unpractised female recently delivered.

But in order to render the plea of inflation by the mother at all feasible, she must have shown in other ways her anxiety to preserve the live of her offspring. She must have made some preparations for her delivery, and prepared clothes for her child. In the great majority of cases of alleged infanticide, no such preparations have been made; and their omission must render the plea of inflation untenable. It would be still less effectual in that large class of cases in which the body of the child bears marks of violence.

Authors have laid down more than one distinction between inflation and respiration, and Metzger gives no less than four diagnostic marks. He states that inflation is distinguished by incomplete distension of the lungs, by flatness of the chest, by absence of crepitation when incisions are made into the lungs, but chiefly by their bloodless state, such state not being accounted for by previous hæmorrhage. All these distinctions are unfounded; for imperfect respiration also produces incomplete distension of the lungs, with perfect flatness of chest, and absence of crepitation; and these may coincide with a bloodless state of the lungs. The static lung-tests have also been used as a means of diagnosis, on the well-founded assumption that inflation does not affect the weight of the lungs; but as these tests do not distinguish respiration from non-respiration, and inflated lungs are, as far as concerns the blood they contain, in the state of lungs which have not breathed, it follows that the static lung-tests cannot distinguish respiration from inflation.

There is fortunately one available distinction on which but little stress has been laid. In all unskilful attempts to inflate the lungs through the mouth, air is introduced in considerable quantity into the stomach. Its absence, therefore, from the stomach would go far to prove that inflation had not been practised.*

If now, by careful inspection of the lungs, we have convinced ourselves that either respiration has taken place or inflation been

* Casper points out as signs of inflation, crepitation on incision without escape of blood-froth, laceration of the cells, a bright cinnabar red colour without marbling, and (perhaps) air in the stomach and intestines. Vol. iii. p. 68.

practised; and further, that the body shows marks of violence, that the stomach does not contain air, and that the circumstantial evidence, strengthened by the general considerations respecting the difficulty of inflating the lungs, render the plea of inflation untenable, and leave no alternative but that the infant had breathed, a further inquiry is still needed before we can assert that it was *born alive,* in the sense the law attaches to that term. The question still to be answered is:—Did the infant breathe before, during, or after birth?

Respiration may take place before complete delivery, *a.* in the womb; *b.* in the passages; and *c.* after the delivery of the head.

a. Respiration may take place in the womb in cases of face-presentation; but this is a rare event, occurring only once in 280 deliveries. In this position, too, respiration would be extremely imperfect, so that any considerable expansion of the lungs would at once negative the supposition of the child having breathed within the womb, and perished before complete delivery.*

b. Respiration may also occur during the passage through the vagina; and especially during the introduction of the hand to facilitate tedious labour, or change the position of the child. It must also be admitted to be possible in the absence of manual assistance, when the parts of the mother are capacious. In this class of cases, too, it is probable that respiration would be very imperfect, so that any considerable distension of the lungs would negative the supposition of respiration having occurred only in the vagina.

c. Respiration after the delivery of the head, and before the complete separation of the body from the mother, is a common event. In such a case there is not likely to be any serious impediment to complete delivery. Schmitt relates no less than nine cases of this kind which occurred in his own practice, and in all of them the child was safely delivered. On the other hand, a few cases are recorded in which children, having breathed in this situation, perished before the completion of the labour; and the same fatal result may happen to children breathing in the womb or in the passages.

The possibility of respiration before the complete separation of the child from the mother is thus placed beyond a doubt; and it must be evident that the mere inspection of the lungs would not enable us to assert positively that respiration took place before, during, or after the birth. But if the lungs are found fully or

* With regard to this "vagitus uterinus"—this respiration in the womb, as a fact of practical value in cases of infanticide, Casper expresses a very justifiable scepticism. Vol. iii. p. 40.

even largely distended with air, we should be justified in assuming that respiration had not taken place only in these situations, but that the child was born alive.

But we may succeed in obtaining better evidence of live-birth than the state of the lungs can afford, by a careful examination of other parts of the body:—of the stomach, intestines, and bladder; of the organs of circulation, umbilical cord, and skin.

The changes in the organs of circulation, umbilical cord, and skin, are both proofs of live-birth, and means of determining how long a child has survived. These points will, therefore, be reserved till the indications to be drawn from the state of the internal viscera have been considered.

The *stomach* may contain milk, or farinaceous food, proving that the child was born alive, and had lived long enough to be fed. Milk is readily identified by its physical characters, by the use of the microscope (see figs. 9 & 10, p. 62), and by Trommer's test, as used for detecting the presence of sugar in urine.* Farinaceous food may be identified by the starch it contains, which has characteristic appearances under the microscope, and strikes with iodine-water a blue colour; and by Trommer's test, if the food has been sweetened. The presence of blood in the stomach also affords a probability of live-birth, for it is more likely to have been swallowed than to have been poured into the stomach as the result of disease.

The large *intestines*, in mature still-born children, are filled with meconium; and though this may be partially expelled during labour, a considerable quantity of it will remain in all cases of still-birth. The complete expulsion of the meconium, therefore, would furnish a strong probability that a child had survived its birth. But, on the other hand, the presence of a considerable quantity in the intestines must not be taken to prove that the child was not born alive, as its expulsion is sometimes delayed for some hours or days.

The *bladder* is commonly emptied of its contents soon after birth; hence, if found empty, it has been assumed that the child was born alive; if full, that it was still-born. But this sign is most fallacious, for the bladder may certainly be emptied of its contents during labour, as it may be replenished should the child survive its birth some time. The statement of Casper that he has

* Trommer's test. Add to the liquid to be examined a few drops of a weak solution of sulphate of copper, and caustic potass in excess, and apply the spirit-lamp. The liquid assumes a deep violet tint, and on being further heated deposits red sub-oxide of copper. This test gives characteristic results with the whey and curd of milk, as well as with liquids containing sugar.

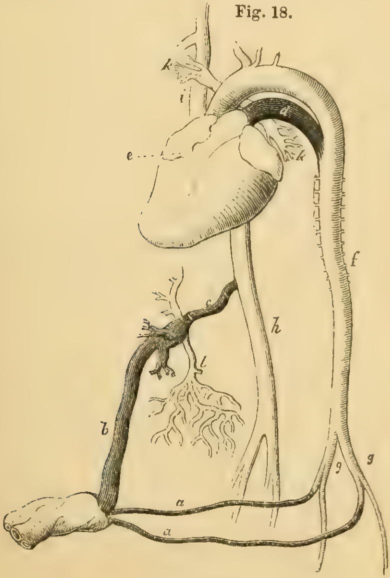
"unnumbered times" found a *full* bladder and an *empty* rectum, or the reverse, deprives these signs, taken together, of any value they might be supposed to possess.

III. HOW LONG DID THE CHILD SURVIVE ITS BIRTH?

Our means of answering this question are less precise than could be desired. The extent to which respiration has taken place cannot be depended upon; and recent observations have tended greatly to impair the value of at least one of the three signs just referred to, namely—*a.* Changes in the organs of circulation; *b.* The state of the umbilical cord; and *c.* The state of the skin.

a. The Organs of Circulation.—There exist in the fœtus certain temporary additions to those organs of circulation which

Fig. 18.



are destined for extra-uterine life. These consist of the umbilical arteries (*a a*), which return the blood of the fœtus to the mother;

the umbilical vein (b), which conveys the blood of the mother, through the intervention of the placenta, to the fœtus; the ductus venosus, (c), which conveys part of the mother's blood direct to (h), the ascending cava; the ductus arteriosus, (d), which conveys the blood destined after birth to circulate through the pulmonary arteries ($k\ k$), direct into (f) the descending aorta; and the foramen ovale (a, fig. 19), situated at (e), which, by establishing a communication between the right and left auricle, makes the double heart of the future breathing animal, a single one during the life in the womb. All these parts, being unnecessary to extra-uterine life, are closed after birth.*

Fig. 19.

The Umbilical Arteries and Vein.—The obliteration of the *arteries* takes place much more speedily than that of the vein. At the end of twenty-four hours they present a marked diminution in their calibre, and an increased thickness of their coats near the umbilicus. At the end of two days the contraction extends through a great part of their length, and at the end of the third day reaches nearly to their termination in the iliacs. The changes in the *umbilical vein* and *ductus venosus* take place much more slowly. During the first three days there is only a slight contraction; on the fourth this is more marked, and on the fifth it is, with few exceptions, complete.

The changes in the *ductus arteriosus* have been minutely described by Bernt of Vienna. The vessel is about an inch in length, uniformly cylindrical, and about the size of the pulmonary artery. After a few respirations it contracts towards the aorta; but after some hours or days, resumes its cylindrical shape by becoming uniformly contracted throughout. At the end of a week it has passed from the size of a goose-quill to that of a crow-quill. On the eighth day the duct is obliterated in half the children, and about the ninth or tenth in all.

The period of obliteration of the *foramen ovale* is extremely variable. Thus Billard found it closed in 1 out of 18 infants of

* In the diagram referred to in the text, $g\ g$ represent the iliac arteries, i the descending cava, and l the vessels of the portal system, derived from the umbilical vein.

a day old; in 4 out of 22 of two days old; in 3 out of 22 of three days old; and in 2 in 27 of four days old. Devergie confirms these observations as to the uncertain period at which the foramen is closed. It often continues open even in the adult, and, in some cases, without producing any dangerous consequences.

Bernt enters into minute details respecting the situation of the opening of the fossa ovalis at different intervals after birth; but these have no practical value. Indeed, the confidence formerly placed in the closure of the several fœtal vessels and of the foramen ovale, as signs of live-birth, and in the order and progress of obliteration in those parts respectively, as means of determining, with some approach to accuracy, how long a child had survived its birth, has been lately rudely shaken; for it has been shown that, on the one hand, all the vessels and the foramen ovale may be found open in children who have survived their birth several days; and, on the other, that the two parts on the obliteration of which the greatest reliance has been placed (the ductus arteriosus and the foramen ovale) may be closed within a few minutes after birth, or even, in rare instances, previous to it.

Of the patency of the fœtal vessels after live-birth a good example is given by Mr. Henry Lee, in his 'Pathological and Surgical Observations,' p. 116. The umbilical vein, ductus venosus, ductus arteriosus, and left umbilical artery, were all open, the right being closed only near the umbilicus, and yet the child from which the preparation was taken died from umbilical hæmorrhage when a fortnight old, and six days after the separation of the funis. Similar cases have been reported by Jörg and others. On the other hand, the little importance which attaches to the closure of the fœtal vessels and foramen ovale is shown by a case reported by Dr. Norman Chevers, to the Pathological Society, January, 1847. The child had survived its birth only fifteen minutes, and yet the ductus arteriosus was found uniformly contracted so as only to admit the shank of a large pin, while its coats exceeded in thickness those of any other large vessel. Dr. Chevers thought that the contraction of the vessel took place before birth; an opinion which receives some countenance from the fact that the duct has been found absent. Of the very early closure of the foramen ovale, a remarkable case was reported by Mr. Smith, at a later meeting of the same Society (Dec. 7, 1847). The child died comatose at the end of sixteen hours, and the foramen ovale was found closed by a strong reticulated membrane firmly attached to its distinct annulus, impervious, and pouched. Dr. Chevers inclined to the opinion that in this case, also, the closure had taken place before birth.

The open state of the fœtal vessels and foramen ovale is therefore no proof of still-birth; and, on the other hand, the contraction of the ductus arteriosus and closure of the foramen ovale are quite consistent with a very short period of survivorship. The medico-legal value, therefore, of these tests of live-birth and survivorship is nearly on a par with that of the static lung-tests. The open state of the vessels will furnish merely a probability of still-birth, and the contraction or closure of one or more of them merely a probability of live-birth. The length of time that the child has survived its birth cannot be safely inferred.

b. Changes in the Umbilical Cord.—In a new-born child the umbilical cord is fresh, firm, round, and of a bluish colour; its vessels still contain blood; and its size varies according to the amount of gelatinous fluid which it contains. The shrinking, withering, or mummification of the cord is the first change: it commences at the ligature, and gradually extends to the umbilicus. In some cases it begins directly after birth; in others, not till some hours have elapsed; it is rarely delayed beyond thirty hours or two days, and never longer than three. The cord is now flabby, and sometimes a distinct red circle is perceptible round its insertion, with inflammatory thickening, and slight purulent secretion. The second change is the *desiccation* of the cord. It first assumes a reddish-brown colour, and becomes semi-transparent; it is then flattened and shrivelled; and when the process is still more advanced it becomes quite transparent, and of the colour of parchment, displaying the umbilical vessels contracted, and containing clotted blood, or completely obliterated. The commencement of this process of desiccation dates from one or two to four days after birth, and it may be complete in from one to five days, but the usual period is three days. The next stage is the falling off of the cord: this usually happens on the fifth day. *Cicatrization* of the umbilicus, the last change, takes place about the tenth to the twelfth day. This description is based chiefly on the observations of Billard.

The changes in the cord of a child born dead, are merely the common consequences of putrefaction. Desiccation does not occur in the cord of a dead child till after the latest period at which it takes place in the cord of a living one; and the cord of a dead child does not separate, though the cuticle can be readily peeled off. Casper has shown that the first change (mummification) is not a vital process; but that it happens with portions of the cord cut off and exposed. He does not, therefore, attach to it "the slightest value as a proof of extra-uterine life!" But he considers the bright red ring surrounding the insertion of the cord, with

inflammatory thickening, and slight purulent secretion, as affording "irrefragable proof of the extra-uterine life of the child." This red line requires to be distinguished from a narrower circle formed in the uterus, and found in still-born children.

c. Change in the Skin.—This consists in an exfoliation of the epidermis, beginning on the abdomen, extending successively to the chest, groins, axillæ, interscapular space and limbs, and ending with the hands and feet. Sometimes the skin comes off in layers or scales, sometimes as a dust. This exfoliation, or desquamation, of the cuticle, may begin when the child is a day old, but it may be delayed till the third or fourth day. It lasts, also, a variable period,—sometimes of thirty days, and sometimes of two months. It continues longest in feeble and delicate children.

This, too, is a vital process, differing essentially from that separation of the cuticle which takes place in consequence of putrefaction. Although the period of its occurrence is variable, its existence affords clear proof that the child has survived its birth.*

The following table, based on the observations of Billard, present, at one view, the principal changes just described, the probable date of their occurrence, and the proportion of cases in which the foramen ovale and ductus arteriosus have been found open.

Days.	Umbilical Cord.	Foramen Ovale.	Ductus Arteriosus.	Umbilical Arteries.	Umbilical Vein.	Ductus Venosus.
		Open per cent.	Open per cent.			
1	Withering.	74	68	Open.	Open.	Open.
2	...	68	59	Obliteration advanced.	Open.	Open.
3	Desiccating.	64	68	Obliterated.	Open.	Open.
4	Separating.	63	63	...	Contracted.	Contracted.
5	...	45	52	...	Obliterated.	Obliterated.
8	Separation complete.	25	15			
10 to	Cicatrization commencing.					
12	Complete.					

The two questions—1. Was the child born alive? and, 2. If

* Billard: 'Maladies des Enfans,' pp. 13–24.

born alive, how long has it survived its birth? having been answered, we may have next to inquire,

HOW LONG HAS THE CHILD BEEN DEAD?

The process of putrefaction does not differ materially in the adult and in the infant. The same changes occur in the same order. The animal heat is first extinguished, rigidity then ensues, and putrefaction follows. The body of the new-born infant parts with its heat very quickly; the rigidity is as great, and lasts as long in the infant as in the adult; and putrefaction, according to Devergie, goes on more rapidly. With the exception of the time required, the principles that will guide us in our decision will be the same at all ages. These will be the subject of a future chapter. The effects of intra-uterine maceration, described at p. 81, must not be confounded with those of putrefaction.

THE CAUSE OF DEATH.

There are several ways in which the life of a child may be sacrificed, within a short period of its birth, without violence on the part of the mother. *a.* It may be too immature or too feeble to maintain an independent existence; *b.* it may encounter obstacles to the continuance of respiration; or, *c.* a congenital disease may effectually prevent the establishment or continuance of the vital functions.

a. The death of an infant after a few respirations, in spite of the most skilful and persevering attempts to restore animation, is an event well known to every accoucheur; and it must be of common occurrence in children born under circumstances which preclude effectual assistance. The most common causes of early death are a long and tedious labour, hæmorrhage, continued interruption to the circulation through the cord; and immaturity or feebleness. It ought also to be understood that the same causes which occasion still-birth promote the early death of children born alive. Thus more large children perish in the birth, or die soon after, than small ones, and more male children (as being larger) than females. Again, the danger to the child is greatest in a first pregnancy. It is probable, too, that in the absence of violence, or even of intentional neglect, illegitimate children would be specially liable to be still-born or to die soon after birth. The reports of obstetric practitioners show that, while the mortality of legitimate children is about 1 in 20, that of the illegitimate is about 1 in 10; while the deaths of males are to those of females as about 7 to 5.

b. The chief obstacles to the continuance of respiration are such a position of the infant as shall cause the mouth to be applied to some soft and yielding object, or to be immersed in blood, the discharges, or water; and the accumulation of mucus in the mouth, nostrils, and air-passages. Respiration may also be altogether prevented, as when the child is born in the membranes.

c. The congenital diseases which prevent the establishment of the vital processes, or render their continuance for any length of time impossible, have their seat in the three organs most essential to life;—the heart, the lungs, and the brain.

Diseases of *the heart and large vessels* are rare in infancy; but malformations accompanied by contraction or early closure of the fœtal vessels have an important medico-legal bearing, as affording a presumption in favour of death from natural causes.

Diseases of the *lungs* are more important in relation to the present question. They are six in number—1. Hepatization (red and grey), the consequence of pneumonia before birth. 2. Pulmonary apoplexy. 3. Tubercles. 4. Œdema. 5. A disease described by Devergie, under the name of œdema lardaciforme. And, 6. A condition known as atelectasis. The three conditions of atelectasis, pulmonary apoplexy, and œdema lardaciforme are illustrated in portions of lungs in the annexed figure, of which 1

Fig. 20.

1. 2. 3.

shows atelectasis as figured by Jörg. 2. The œdema described and figured by Devergie. And, 3. Pulmonary apoplexy from the lungs of a child three weeks old, one of several infants that had died about the same age from embarrassed respiration.

These diseases of the lungs may affect either their entire structure or a part only. When the whole lung is involved, it is clear that respiration cannot be perfectly established, and that the child cannot long survive its birth; when, however, the disease is partial, the medical man must state, to the best of his judgment, what effect it is likely to have had in shortening life.

The condition of lung to which Dr. Jörg of Leipsig has given the name of *atelectasis* or imperfect expansion, is not, strictly speaking, a disease, but merely an absence of respiration and persistence of the fœtal condition, found to a greater or less extent in most new-born children, and continuing for days or weeks. The substance of the lungs in the unexpanded parts is perfectly healthy.

The chief diseases which affect the *brain and spinal marrow* are apoplexy, accumulations of fluid, and morbid softening. The apoplexy of the fœtus and new-born infant differ in no respect from that of the adult. M. Lasserre (Ranking's 'Retrospect,' vol. iii. p. 342) gives a case of meningeal apoplexy, a second of effusion of blood into the ventricles, and a third into the posterior part of the left hemisphere. When serum exists to a limited extent between the membranes or in the ventricles, life is not necessarily compromised, at least not within a short period of birth; but when the accumulation is considerable, it affords a sufficient explanation of the premature death of the child. The same remark applies to morbid softening of the brain and spinal cord. It must be borne in mind, however, that the brain of the fœtus is naturally soft and vascular.

Of all the diseases just specified, it may be remarked that they are not of frequent occurrence; and that when present, it is rarely to such a degree as to account for speedy death, or to have an important bearing on the question of infanticide.

It is only when proofs of respiration are present that these signs of death from natural causes have any value; and, in the case of children who have survived their birth but a short time, the absence of marks of violence affords a fair presumption that death was due to natural causes. It is true that the child may have died through intentional neglect—from the want of those simple aids by which the lives of children in more favourable circumstances are preserved; or the breathing may have been arrested by closing the mouth and nostrils; but these causes of death leave no distinct marks behind them, and the accused must have the benefit of the doubt that attaches to the case.

Was the Death due to Violence.—In answering this question we have to bear in mind the fact that fatal injuries may be the result of accident as well as design.

In some cases we may decide without hesitation that they were due to murderous violence. Punctured wounds of the fontanelles, orbits, heart, or spinal marrow; dislocation of the neck; separation of the head from the body; extensive fracture of the bones of the head and face; suffocation by plugging the fauces; or strangula-

tion effected with unusual force, tell their own tale. But there are other cases in which the nature and cause of the injury can only be determined by reference to obstetric experience and medico-legal experiments, illustrating the mechanical injuries a child may sustain during and immediately after the birth.

Suffocation.—Respiration, as already stated, is sometimes prevented or arrested by accidental causes which leave no mark of injury on the child; so that it cannot be stated whether the child fell into the position of danger, was intentionally placed in it, or was allowed to remain there when it might have been rescued. This difficulty presents itself in a case of not uncommon occurrence. A child is found in a privy, and the question arises whether it was suffocated by being thrown into it, or expelled while the mother was there for a natural purpose. In such a case, if respiration is found to have taken place extensively or completely there is a strong presumption against accident. On the other hand, very imperfect respiration affords an equally strong probability the other way.

Many cases of sudden parturition in such situations are on record. Jörg relates the case of a pregnant woman who "on account of a desire to evacuate the bowels, went to the night-stool, and brought forth sitting on this, without any pain or bearing down, a large boy, who first struck the edge of the night-stool with his head, and then fell on the ground."* There was an extravasation of blood on the left parietal bone. Mr. Tatham also mentions the case of a married lady delivered of twins on the night-stool. It was not her first labour, but probably her second. Both children died.† Such cases of sudden parturition are rare in women who have not previously borne children. It must be admitted, then, as *possible*, that a fœtus found in a privy may have been suddenly discharged and suffocated. Sometimes the child so expelled falls into water instead of into night-soil. In this case, and generally when an infant is found in water, a question arises whether death took place by drowning, or the child was placed in the water to conceal some other mode of death.

Suffocation by the introduction of such matters as mud, straw, feathers, wool, and wet linen into the mouth is not an uncommon cause of death. The question whether the foreign substance could have been drawn into the mouth with the breath, or was intentionally introduced, must be determined by its quantity and compactness.

Another mode of effecting suffocation is by rolling the tongue

* 'Die Geburtshülfliche Exploration,' p. 116.
† 'London Medical Repository,' vol. i. part iv. New Series.

back into the throat. As the tongue would probably resume its original situation, it is not likely that this cause of death would be detected.

Strangulation.—A child may be strangled by a cord, and yet no marks of violence appear on the neck. But even when there is a discoloured depression round the neck, it is not certain that this has been caused by the mother; for it might arise from the twisting of the navel-string, or by the pressure of the neck of the womb. The production of marks of strangulation by these causes has been denied, especially by Klein, who affirmed that he had never met with ecchymoses or suggillations produced by the orifice of the uterus, or by the umbilical cord, though he had known a great number of cases in which the neck of the infant had been strongly girded by the funis once or twice twisted round it, so as either to produce strangulation, or to render it imminent. But a case mentioned by Jörg shows that the experience of Klein is not to be implicitly trusted :—"The navel-string had been twisted five times round the neck, and had left five tolerably deep red impressions." Taufflieb also has reported cases of the same kind,* and there are several English cases to the same effect. Klein speaks quite as decidedly of the pressure of the neck of the uterus; not a bruise, as he tells us, or mark of any kind being left on the infant which has perished in this way.

The mark produced by the navel-string is broad, continuous, grooved, rarely single, not excoriated, but sometimes consisting in parts of bloody extravasations. The contraction of the neck of the womb produces a broad depressed livid stripe.

The presumption in favour of strangulation by the navel-string admits of being rebutted in those cases in which the cord is unusually short; for though it is usually about the length of the body itself (say 18 inches), it may be as short as $4\frac{1}{2}$, and as long as 69, inches. (Churchill.)

Marks of pressure on the neck, therefore, cannot always be attributed to intentional violence; but as a murderer generally uses more force than is necessary, it often happens that the marks are too distinct to be accounted for by the accidental twisting of the umbilical cord round the neck. If the cord itself were used as a ligature, it would probably be applied with undue force. Moreover, if respiration is found to have been completely established, there will be the strongest presumption against the strangulation having been produced by a cause acting during the birth. On the other hand, the absence of signs of respiration affords a

* 'Annales d'Hygiène,' vol. xiv. p. 340.

presumption in favour of the constriction having been due to a cause acting before the birth.

It may be well to state that the twisting of the navel-string round the neck does not always occasion a fatal compression; for it appears from facts industriously collected in Germany, that the deaths attributable to this cause form about 1 in 38 of the cases in which it is present. These results form a striking contrast to those that follow prolapse of, and consequent pressure on, the cord, which is shown to be fatal in more than half the cases. It ought also to be understood that when the cord is tightly drawn round the neck, death does not always result from simple strangulation. It may be caused by interruption to the circulation through the cord—an interruption which, however brought about, occasions efforts at inspiration to which Casper attributes the ecchymoses of the lungs, described at p. 84, and the filling of the air-tubes with liquor amnii.*

Strangulation may also be effected by the pressure of the fingers on the throat, leaving bruises corresponding with the cause.

Drowning.—The signs of this form of death, which are the same in the infant and in the adult, will be described in a future chapter.

Fracture of the Skull.—This may happen in four ways:—1. Within the womb. 2. During labour. 3. By falls. 4. By intentional violence.

1. From cases cited by Casper (vol. iii. p. 109) it may be inferred that fractures of the fœtal skull may be occasioned by falls of the mother from a considerable height. Such fractures have, however, from the nature of the case, no medico-legal interest.

2. That the skull may be fractured during labour is proved by more than one well-authenticated case. Siebold relates the case of a female with a very narrow pelvis delivered, by the efforts of nature alone, of a well-formed still-born female child. On examining the head, a great quantity of blood was found on the surface of the cranium, and there were three fissures in the left parietal, and one in the left half of the frontal, bone. Michaelis of Kiel also reports the case of a woman with a well-formed pelvis, who was delivered of her first child after a natural labour. The child breathed during and immediately after birth, but then died. The head was much disfigured; and on examination, the right parietal bone, which during birth had been directed under the promontory of the sacrum, was covered anteriorly and above with effused blood, and on the removal of the periosteum

* See Casper's Handbook, vol. iii. p. 125.

was found fractured in five places. The whole of this bone was uncommonly thin. On opening the skull there was no extravasation beneath the fissures, but the longitudinal sinus was ruptured, and there was an extensive coagulum on the cerebrum on both sides, under the dura mater, and on the tentorium.* These two cases show the great amount of injury which the head may sustain during birth.

Seeing, then, that such fractures of the skull do occur, what is the difference between them and such as are the result of intentional violence? There is no essential difference, except in those cases in which unusual violence is used, and the fracture is minutely comminuted and accompanied by depression; or is not limited, as commonly happens with fractures caused by pressure of the womb, to the parietal and frontal bones, but extends to other bones of the skull, and even to those of the face. The discovery of defective ossification in the cranium of the new-born infant would explain the occurrence of fissures and fractures, without the necessity of assuming intentional violence.

3. On the subject of fractures of the skull caused by falls, some important experiments and observations have been made. Chaussier caused fifteen still-born children to fall from a height of 18 inches on a stone floor, and found that in 12 of them one or both of the parietal bones was broken. When the height was 3 feet and upwards the same number of fractures occurred, and in a few, the injury extended to the frontal bone. These facts have but an indirect bearing on the case of fractures of the skull occurring during birth.†

But Klein adduced facts which seemed to render it doubtful whether fracture ever occurs in sudden labours from falls on the floor. He availed himself of his official opportunities in the kingdom of Würtemburg, to procure returns of all such labours occurring within his jurisdiction. They amounted to 183 well-authenticated cases, in 150 of which the mothers were suddenly delivered standing; yet there was not a single death among them, nor fracture of the skull, or other mischief; though some of the children had fallen on bare boards, and some on the pavement. The reason of the difference between Chaussier's experiments and these cases is supposed to be that, in the latter, the body of the infant is projected‡ obliquely, so as to break the fall. But cases reported by Casper show that the sudden expulsive

* These cases are quoted by Beck, Art. Infanticide.

† 'Considérations Médico-légales sur l'Infanticide,' par Lecieux.

‡ Casper, it should be observed, takes exception to many of the returns on which these statements of Klein are founded.

power of the uterus must be set off against these causes tending to break the fall. In no less than five instances the child is described as having been *shot* from the mother; and in one of them it is stated to have been *fatally injured.* This group of cases is also interesting as proving that, in rare instances, the height of the child's fall may exceed that of the distance from the genitals of the mother to the ground. The conclusion which Casper draws from his reading and personal observation is as follows:— "A parturient female may be surprised by the last act of birth in every position, even when erect, that the child may be thus forcibly expelled from her genitals, and may be thereby injured, particularly on its head, and that even fatally." (Handbook, vol. iii. p. 133.)

But the truth appears to lie between the experiments of Chaussier and the facts collected by Klein; for Dr. Cohen von Baren has succeeded in bringing together several instances of fracture of the skull from falls during sudden delivery. Out of his 50 cases, 30 were born while the mother was standing, 17 while stooping or sitting, and 3 while kneeling. Of the 50, 32 were first-born, and 42 at full term. Of 19 infants born while the mother was standing, one only had fracture of the skull, and the cause of this was doubtful. But out of 25 cases in which the cord was ruptured, 5 presented fractures of the skull. These fractures occasioned by falls can also be distinguished from those due to intentional violence only by the comparatively slight amount of injury contrasted with the great extent of that intentionally inflicted. When we find comminuted fractures of several bones—the parietal, frontal, and occipital—we are justified in attributing them to murderous violence.

In fracture of the skull due to a fall during sudden delivery, the umbilical cord is liable to be torn through, especially if it does not exceed, or falls short of, the usual length. The seat of the rupture is usually within one or two inches of the navel. If the cord, instead of being torn, is found cut through, it may be inferred that the injuries to the head were not due to accident. In any case, the state of the cord ought to be ascertained.

4. Fractures of the skull by intentional violence are characterized, as a general rule, by the undue force employed.

Fracture and Dislocation of the Neck.—These injuries are never present before birth; and as they are not caused by falls on the floor, they may be taken as sure signs of criminal violence.

Contusions.—In reference to bruises on the head it must be borne in mind, that as compression of the head during labour occa-

sions a livid swelling, such an appearance must not be attributed to criminal violence.

Incised and Punctured Wounds.—There is nothing peculiar in these wounds when inflicted on the new-born infant. For the distinction between them and other injuries inflicted during life and after death, the reader is referred to the subject of Wounds.

Poisoning.—The rules for the examination of the stomach and intestines, and their contents, are the same for the infant and the adult; and will be treated under the general head of Poisoning. This is a rare cause of death in new-born children; but several cases of poisoning by the mineral acids, characterized by the same appearances on the body and clothes of the infant as mark the action of those acids on the adult, have occurred. But the crime was committed at a considerable interval after the birth of the child. It should be borne in mind that the alimentary canal, in common with other important organs of the economy, is subject to disease. Sometimes the lining membrane of the *œsophagus* presents a marked injection, in the form of spots, longitudinal lines, or ramifications. These may happen to be arranged transversely, and may be mistaken for the effects of a ligature applied to the neck. *The stomach,* moreover, may be the seat of ulcerations with a sanguinolent, dark-coloured discharge; and the same changes may be found in other parts of the alimentary canal.

Infanticide by Omission.—The omission to tie the umbilical cord sometimes proves fatal; and there can be no doubt that it is sometimes a criminal act. That such an omission may be attended with danger, is proved by a case related by Foderé, in which the child perished from the ligature becoming loose;* and Dr. Campbell reports two fatal cases, one from the accidental, the other from the intentional, removal of the cord.†

But it is probable that fatal hæmorrhage would rarely follow a *rupture* of the cord; and this probability is strengthened by the testimony of Klein. Such a rupture is not necessarily the act of the mother; it may occur, as already stated, in cases of sudden delivery taking place in the erect posture.

The signs of death by hæmorrhage are the paleness of every part of the body, and the small quantity of blood contained in the heart and large vessels. In the absence of wounds to account for the bleeding, this bloodless state may be regarded as the probable effect of hæmorrhage from the cord.

The child may perish by other acts of omission. The mother may have failed to provide proper clothing or food, to remove it

* Vol. iv. p. 515.

† 'Introduction to the Study and Practice of Midwifery,' p. 151.

from a position of danger, and to clear the mouth of mucus, or other accidental impediments to breathing. Death from want of food would betray itself by the great emaciation of the whole frame, and the empty state of the alimentary canal; and death by starvation and cold combined, by pallor of the surface, with congestion of the internal parts.

Such cases of infanticide by omission, being difficult of proof, are not punished with death, but the mother is convicted of the lesser crime of concealing the birth; and even when there are marks of violence on the body, the inquiry assumes so complicated a shape, that the jury cannot be induced to return a verdict of wilful murder.

EXAMINATION OF THE MOTHER.

The first inquiry with reference to the female suspected of having given birth to the child is,—Whether she has been recently delivered, and if so, whether the period of her delivery corresponds with the time at which the child is supposed to have been born. This part of the inquiry belongs to the subject of delivery (p. 61).

Another inquiry is sometimes necessary; and that is into the state of the mother's mind. Puerperal insanity is not a rare disease, and it may take the form of homicidal mania, threatening the life of the child. An interesting case of this kind is quoted by Paris and Fonblanque.* A married woman, of good reputation, was delivered of a child, and not having slept many nights, fell into a temporary frenzy, and whilst alone killed her infant; but company coming in, she told them that she had killed it, and *there* it lay. The good reputation which she had previously borne, the long want of sleep, and the entire absence of the usual motives to such a crime, added to "many circumstances of insanity appearing," led to her acquittal. Dr. Paris observes, in reference to this case, that "had this woman been of doubtful character, though innocent, she might have been executed for want of medical evidence to prove the nature and frequency of puerperal insanity."

A question of some importance in its bearing on infanticide, and having reference to the mother, relates to the strength which a female recently delivered can exert. There is no doubt, that, as a general rule, she has the strength requisite for the destruction of her child. Thus, Foderé relates the case of a French widow, who being seized with labour pains while receiving a visit from eight of her neighbours, complained of colic, and seating herself

* 'Medical Jurisprudence,' vol. iii. p. 129.

on a bucket in bed, as soon as the child's head passed the vagina, squeezed it flat by compressing it with her thighs. That a woman has strength enough to move about and exert herself after her delivery, is proved by the successful concealment of the fact of delivery, and of the dead infant, in the majority of cases brought to trial; as well as by well-authenticated instances of females walking several miles, or resuming laborious occupations, on the very day of their delivery.

This subject of infanticide will be best brought to a conclusion by the following summary of the chief points to be attended to.

1. Examine the body of the child to determine its degree of maturity; for this purpose, weigh and measure it, ascertain the position of the centre of the body, and attend to the several points comprised in the description of the growth and development of the fœtus (p. 66). Note also any malformation that may be present.

2. Note the several circumstances by which the time that has elapsed since the death of the child may be determined, such as the presence or absence of animal heat and rigidity, the existence or non-existence of putrefaction, and, if putrefaction be present, the degree to which it has advanced.

3. Examine the entire surface of the body with a view to discover marks of violence, and, if any be present, determine whether they might have been produced during birth, or by accidental causes acting afterwards. Examine the mouth for foreign bodies introduced into it, and the fontanelles, orbits, heart, and nuchæ, in search of wounds inflicted by pointed instruments. Note the state of the umbilical cord, measure it, and ascertain whether it has been torn or cut; and observe the condition of the skin.

4. Open the chest, and remove the heart, lungs, and thymus gland. Separate the lungs, and carefully inspect their surface. Observe whether they are of a uniform liver-colour and compact consistence throughout, or uniformly spongy like the adult lung, or mottled with developed air-cells, as in imperfect respiration. If there are parts of a lighter colour than the rest, observe whether the texture of the lung is developed in those parts, and distinguish the developed cells from air the product of incipient or advanced putrefaction, by applying gentle pressure with the finger. In lungs free from putrefaction, the hydrostatic test may be resorted to, to ascertain their degree of buoyancy, as a rough measure of the quantity of air which they contain.

5. Examine the heart and foramen ovale; the ductus arteriosus and venosus; and the umbilical arteries and vein. Observe whether these parts are contracted, and to what extent, or obliterated; and whether they contain much or little blood.

6. Examine the stomach to ascertain whether the child has been fed, using for this purpose the tests for sugar, milk, and starch; if there is any appearance of inflammation in the alimentary canal, test its contents with a view to the discovery of poison. Note whether the intestines contain meconium and in what quantity, and whether the urinary bladder contains urine.

7. Examine the bones of the skull both at vertex and base, in search of fractures. Inspect the brain and its membranes, and note any effusion of blood or serum. Examine the spine with a view to the discovery of dislocation or fracture of the vertebræ.

8. Examine the suspected female in order to ascertain whether she has been recently delivered, and how long. In certain cases, inquire into the state of the woman's mind.

LEGITIMACY.

A child born in wedlock is presumed to have the mother's husband for its father; but this presumption may be rebutted by evidence of non-access, or of impotence.

There are several circumstances out of which the question of legitimacy may spring. 1. A woman may bear a child after her husband has been absent more than nine calendar months; and in this case the question arises, Does the period of utero-gestation admit of being extended beyond this the *usitatum tempus pariendi?* 2. A woman within an unusually short period of her marriage may bear a child capable of being reared, and here the question arises, what is the earliest period at which a viable child may be born? 3. A woman before the expiration of nine calendar months from the date of her marriage, say in the 7th or 8th month, may be delivered of a child having the size and general appearance of one at full term; and it may become a question whether a child apparently so mature, could have been of the supposed age. 4. A woman may give birth to a child during the life-time, or after the death, of her husband, he having been at the date of the conception in such a state of feebleness or disease, or imperfect convalescence from some severe malady, as to raise the question whether he could have been the father of the child. 5. A husband dies suddenly in perfect health, and shortly after his death his wife bears an immature child, and after an interval a second at full term or approaching maturity, and here the question arises whether the second child was the issue of a superfœtation. A question of paternity may also arise, where there is no doubt of the legitimacy of the child, in consequence of the marriage of the mother to a second husband immediately after

the death of the first. For cases of disputed legitimacy turning on the alleged impotence of the husband, see "Impotence," p. 32. The questions which fall to be examined in this place are chiefly —1. *The Duration of Pregnancy.* 2. *The Viability of Children.* 3. *Superfœtation.*

I. DURATION OF PREGNANCY.

Though the practice of our courts of law is to consider forty weeks as the more usual duration, medical men are allowed to give evidence as to the possibility of that period being extended.

The period of utero-gestation in the human subject is generally stated at 9 calendar months, 10 lunar months, 40 weeks, or 280 days; and we often meet with the less definite expression "9 months, or 40 weeks." But there is a material difference between 9 calendar months on the one hand, and 10 lunar months, 40 weeks, or 280 days, on the other; for nine calendar months may consist either of 273, 274, 275, or 276 days, falling short of 280 by from 4 to 7 days.

Another source of inaccuracy in estimating the duration of pregnancy springs from the uncertainty attaching to more than one of our means of fixing the date of conception. These means are *four* in number.

1. *Peculiar Sensations* attending conception. 2. *Cessation of the Catamenia.* 3. *The Period of Quickening:* and 4. *A single Coitus.*

1. *Peculiar Sensations attending Conception.*—This mode of reckoning is open to the objections that these sensations are not so defined as to be recognised by those who conceive for the first time; that they are not constant in their occurrence in the same female; and that they do not take place at the exact time of the conception.

2. *Cessation of the Catamenia.*—To this mode of reckoning there are the obvious objections, 1. That the catamenia may cease from causes other than conception; so that a woman who, from some such cause, ceases to menstruate, and conceives immediately before or after the next suppressed period, may date the conception from the first period. 2. A woman may menstruate once, or more than once, after conception. In the first case the reckoning would exceed, in the second it would fall short of, the true duration. 3. That at the best it can only give an approximative result; for if we assume 28 days to intervene between the commencement of one menstrual period and that of the next, there may be an interval between the termination of one period and the beginning

of the next of nearly 28 days; say 24 days. If conception be assumed to take place on the day *following* the cessation, and we reckon from the first suppressed period, the calculation would fall short of the real duration by 24 days. If, on the other hand, we assume conception to take place on the day *preceding* the cessation, and we reckon from the last appearance of the menses, the calculated would exceed the real duration by the same period of 24 days.

To avoid this possible error of 24 days, the expedient has been resorted to of dividing the interval into two parts, and reckoning from the division. In this way the possible error is reduced to 12 days.

In those cases in which the interval is contracted, either by the menses continuing for several days or recurring every three weeks, or every fortnight, the possible error would be less; on the other hand, it would be greater in those instances in which the interval is prolonged to five or six weeks, or even two months.

3. *Period of Quickening.*—This starting-point is sufficiently condemned by the simple statement, that quickening, when it is perceived, occurs at very variable periods, having a range of at least six weeks (from the 12th to the 18th), and if we combine the statements of several authors, of sixteen weeks, namely, from the 10th to the 26th.

4. *A single Coitus.*—This is the only accurate mode of reckoning; and a sufficient number of well-attested facts of this class has now been collected to prove that the duration of pregnancy is subject to considerable variation, as well as to a marked excess above 280 days.

Thus 14 cases yield an average of 284, a minimum of 270, and a maximum of 293 days. The range was therefore 23 days, the excess above 280 days 13, and the excess above 9 calendar months, 17 to 20.

The inferences drawn from cases in which the duration of pregnancy is fixed by a single coitus, are strengthened by cases of an analogous kind, in which the sudden death of a husband, or the date of separation from his wife, is used to determine not the exact but the minimum duration of pregnancy, for in using this mode of reckoning it is assumed that conception took place on the very day of death or departure.

27 cases in which the duration was thus fixed by single coitus, or sudden death or departure of husband, gave an average of 284, a minimum of 260, and a maximum of 308 days.* The

* The case of 308 days was supplied by Mr. Hewitt, a former pupil of

range was therefore 48 days, the excess above 280 days 28, and the excess above nine calendar months, 32 to 35 days.

There is, therefore, the strongest reason to regard the period of utero-gestation as variable and not fixed; and as this variation occurs in so small a number of cases, we may fairly expect a still greater divergence from the collection of a greater number of facts.

This inference derives the strongest confirmation from the analogy of animals. Formerly the period of gestation in animals was also held to be fixed; and it was laid down as at 11 calendar months in the mare, and 9 in the cow. But it is now ascertained that the period in these animals is far from being fixed.

The well-known observations of M. Tessier, which extended to 102 mares and 160 cows, give the following striking results:—

Shortest period:—	Mare	311 days.	Cow	241 days.
Longest period .	„	394 „	„	308 „
Range	„	83 „	„	67 „
Excess above the stated period	„	57 or 60 „	„	32 or 35 „
Average period .	„	11 mths. 10 „	„	9 mths. 10 „

The late Earl Spencer made a still more extensive series of observations on 764 cows,* with results which may be briefly stated thus:—

Shortest period (calf living)	220 days.
Shortest period (calf reared)	242 „
Longest period	313 „
Range (calf living)	93 „
Range (calf reared)	71 „
Excess beyond 260 days, before which time a calf was deemed immature . . .	53 „
Excess above 9 calendar months	37 or 40 „
Excess above 10 lunar months	33 „
Average duration	284 or 285 „

The majority of instances of gestation protracted beyond the average period, occurred in the case of bull calves, the numbers being, of cow-calves 90, of bull-calves 152.

These observations of M. Tessier and Lord Spencer prove that the period of gestation in the cow and horse, which, like that of the human subject, was formerly regarded as fixed, is not only

King's College. The duration was ascertained by the sudden death of the husband. Cases of less than 260 days are excluded.

* See the 'British and Foreign Medical Review' for Jan. 1841.

variable, but that the extremes are widely separated from each other, and the longest period in excess by considerably more than a calendar month of the average.

The case in favour of a variable period in the human subject admits of being strengthened by other arguments.

All the functions of the human body which have been carefully examined, such as the cutting of the teeth, the pulse, the respiration, are found to vary within wide limits. So also with the functions more directly connected with pregnancy: the catamenia may appear at any age, from 9 years, or earlier, up to 23 or 24, or later; and they may continue up to any age from 35 to 55, or even later. They may also recur at intervals of a month, six weeks, or a fortnight, and each period may comprise a variable number of days. Then, again, the period of quickening varies from the 10th or 12th to the 18th or 20th week, or even later; and child-bearing, which has usually ceased by 45 years, may occur as late as 54, and possibly at a still more advanced age.

Another argument of no slight force in favour of a variable period, and of the possible extension of pregnancy beyond the limit usually assigned, is found in the fact that the advocates of a fixed period are not agreed among themselves as to what that fixed period is. Thus, of the seventeen medical men examined in the Gardner Peerage case, five advocated a fixed period, and opposed the idea of protracted gestation; but all of them, with the exception of Sir Charles Clarke, who fixed it at 40 weeks or 280 days, stated the duration differently, and were forced to admit a greater or less deviation from a fixed standard. Dr. Gooch stated it at from a day or two before to a day or two after 9 calendar months, and Dr. Davis at a day or two under 9 calendar months; while Dr. Blegborough allowed an interval of from 39 to 40, and Mr. Pennington of from 37 to 40 weeks.

But while five of the seventeen medical men supported the opinion that the period of gestation was fixed, or nearly so, twelve believed that it might be protracted to 9½, 10, or 11 calendar months, or (288—290) (304—306) (334—337) days.

The balance of authority, both ancient and modern, may be also adduced in support of the theory of a variable period, and of possible extension of pregnancy beyond the usual period of about 280 days.

To the foregoing arguments may be added the fact, that legal decisions in this country have been favourable to protracted gestation, and that the same may be said of the decisions and even of the laws of other countries. Thus the Code Napoleon allows

300, and the Prussian law 302 days, and a recent decision in the United States was in favour of 317 days.*

The period of utero-gestation, therefore, being subject to variation, and admitting of extension beyond 280 days, a question now arises as to the limit of that extension. What is the longest possible duration of pregnancy?

The 14 cases fixed by a single coitus give, it will be seen, a maximum of 293 days; while the 27 based jointly on a single coitus, and the death or absence of the husband, extend the period to 308 days. One of two cases by Prof. Simpson brings the figures up to 313 days, and two cases by Murphy up to 314 and 324 days respectively.

The question, of the extent to which the period of utero-gestation may be protracted beyond 280 days assumed a definite shape in the celebrated Gardner Peerage case, of which the following is a brief outline.

In the month of March, 1796, Alan Hyde Gardner, afterwards Lord Gardner, a captain in the navy, was married to Miss Adderley; and they cohabited as man and wife till January, 1802 (except during the occasional absence of the husband). On or about the 30th of January, Captain Gardner took leave of his wife, sailed a few days afterwards for the West Indies, and did not return to England till the 10th of July in the same year, his wife remaining in England during the whole of that period. Towards the end of the year 1801, when Captain Gardner was absent on his Majesty's service, his wife entered into an adulterous conversation with Henry Jadis, Esq., which Captain Gardner did not discover till June, 1803; after which time he did not have any intercourse whatever with his said wife. On the 8th of December, 1802, she was, without the knowledge of Captain Gardner, delivered of a male child, afterwards baptized by the name of Henry Fenton Gardner. In Easter Term, 1804, Captain Gardner brought his action in the Court of King's Bench against Henry Jadis, for criminal intercourse with Maria Elizabeth Gardner, and obtained a verdict for 1000*l.* damages. He also obtained a sentence of divorce in the Consistory Court, and the marriage was subsequently dissolved by Act of Parliament. Baron Gardner died on the 30th December, 1808, leaving Captain Gardner his eldest son and heir, who thereupon succeeded to the barony, as Alan Hyde, Lord Gardner. On the 10th of April, 1809, he was married to the Honourable Charlotte Smith, daughter of Lord Carington, and by her had issue an only son,

* 'American Journal of Medical Science,' October, 1845.

Alan Legge Gardner, born on the 29th of January, 1810, and one daughter. Alan Hyde Lord Gardner died the 27th of December, 1815, leaving Alan Legge Gardner successor to the title. Henry Fenton Gardner attained the age of twenty-one in the month of December, 1823; and Alan Legge Gardner, being an infant of about fourteen years of age, petitioned his Majesty for a recognition of his right to the title by letters patent, or by ordering his name to be entered on the Parliament Roll as a minor peer.*

It was proved on the trial that there was a possibility of access on the 30th of January, 1802, from that date to the 7th of February, and on or after the 11th of July. Hence the three questions proposed to the medical witnesses:—

1. Could a child born on the 8th of December have been the fruit of sexual intercourse on the 30th of January, being 311 days?

2. Could a child born on the 8th of December have been the fruit of sexual intercourse on the 7th of February, being 304 days?

3. Could a child born on the 8th of December, and living to manhood, have been the fruit of sexual intercourse on or after the 11th of July, a period of 150 days, or two or three days short of five calendar months?

The first two questions may be reduced to one, so as to give the following alternative:—if the child were legitimate, he must have been either a 150 days' child, or a 304 or 311 days' child (one calendar month and two or nine days beyond the *usitatum tempus pariendi*).

The latter alternative, viz., gestation protracted to the 304 or 311 days, was the one chiefly insisted upon in this celebrated trial; but the decision of the case did not turn upon the medical evidence. The adultery of the mother of Henry Fenton Jadis having been proved, the claim of the petitioner, Alan Legge Gardner, was allowed.†

II. VIABILITY OF CHILDREN.

The question, What is the shortest period of gestation at which a *viable* child may be born? was raised in the Jardine case, which, though less known than the Gardner Peerage case, is equally interesting, as no less than 14 medical men, and a still greater number of non-professional witnesses gave their evidence. In this case, too, there was great difference of opinion among the

* This account is abbreviated from Le Marchant's history of the case.

† For fuller particulars consult Dr. Lyall's summary of the 'Medical Evidence relative to the Duration of Human Pregnancy, as given on the Gardner Peerage Case.'

medical witnesses. The evidence of Drs. Alison and Christison was admitted because, as Lecturers on Forensic Medicine, their attention had been directed to the question involved; and it may be safely affirmed, that the evidence of Dr. Christison threw more light upon the case than that of all the other witnesses put together.

The following is a short abstract of this case:—

The defendant was married on the 3rd of March, 1835; and on the 24th of August following, his wife was delivered of a girl. Supposing this child to have been the fruit of sexual intercourse on the day of the marriage, it was only 174 days, or five calendar months and 21 days old. The infant, which was undoubtedly immature, though to what degree could not be ascertained or determined, died on the 20th of March, 1836, having survived, as nearly as possible, seven months.

The libel charged the defendant with having committed fornication with his wife before marriage. A great many witnesses were called, some to establish the possibility of sexual intercourse before marriage, others to show that the child, though small and feeble, was not immature, or at least not so immature as the date of the marriage would make it; and others to speak to the impossibility or improbability of a child surviving at that early period. The extent to which the allegations of the libel were made good, and the vague nature of the evidence adduced in their support, will be best seen by the following extract from the decision of the Presbytery, November 7th, 1838:—"That the testimony of the several witnesses, both with respect to matters of fact, viz., the appearance of the child at birth, &c., and also with respect to the opinions of medical men regarding the viability of such a premature child as the child in question is said to be, is of such an opposite and contradictory nature, that the Presbytery, with their present light, have great difficulty in coming to any decision on these points. The Presbytery, therefore, agreeably to a common maxim of law, *Satius est impunitum relinqui facinus nocentis quam innocentem damnari*, find the libel not proven."*

The principal points established by the general and medical evidence in relation to Mrs. Jardine and her infant were, that she had menstruated as usual the week previous to her marriage; that she was, both before and after her marriage, in a very weak

* 'Record of the Proceedings in the reference by the Synod of Fife, to the Venerable the General Assembly of the Church of Scotland, in May, 1839, of the Case of Mr. Thomas Barclay, Town Clerk, and Nine of the Parishioners of Kinghorn, against the Reverend Fergus Jardine.' Edinburgh, 1839.

state of health; that she was herself a seven months' child; that she had a second child, a daughter, which she believed to have been born "just about the commencement of the eighth month of her pregnancy," and that she had not provided baby-linen for this child. As regards the infant, the evidence, though contradictory on many points, showed that it was small (it weighed three pounds when born), very feeble, and decidedly immature, though no data were adduced to show the degree of immaturity. It required to be nursed with care, but not with those extreme precautions for preserving warmth, which seem to have been absolutely necessary in the cases of Drs. Rodman and Outrepont, presently to be described.

The special question raised in the Jardine case was this—Could a child born 174 days, or five calendar months and twenty-one days after marriage, be reared to the age of seven months? and the general question which the case suggests is—What is the earliest period of gestation at which a viable child may be born?

Now it is universally admitted that a child may be born and reared to manhood as early as the seventh month; and as generally believed that a viable child cannot be born before five calendar months, or 150 days.

In order to test the soundness of this opinion, and to ascertain the earliest date at which a child may be born alive and reared we must consider two distinct orders of facts. 1. Facts which afford a presumption in favour of early viability by showing that infants born alive at an early period have survived a few hours or days; and 2. Facts of the same order relating to infants that have been reared to adult age, or to such an age as affords reasonable presumption in favour of their having attained that age.

1. To this first class belong such cases as those of Mr. Thomson,* in which an infant believed to have lived to 5 months, survived $3\frac{1}{2}$ hours; of Christison,† in which one of 167 days old survived $8\frac{1}{2}$ hours; of Bucholtz,‡ in which one of 189 days old survived 2 days; of Kopp,§ in which one of 182 days survived $4\frac{1}{2}$ days; and of Fleischmann,|| in which one of 168 days survived 8 days.

Dr. Bonnar¶ has compiled a table comprising no less than

* Of Alva, Stirlingshire, quoted by Beck.

† Evidence in the Jardine case.

‡ Beiträge ii. 104. § Jahrbuch, iii. 128.

|| Henke's Zeitschrift, vi. 12.

¶ 'A Critical Inquiry regarding Superfœtation, with cases.' By George

112 cases of infants born alive at periods varying from 120 to 210 days; and if from this collection of facts, more or less well authenticated, we omit 39 cases of infants born at 210 days, and about which there need be no dispute, there remain 73 infants born alive at various ages from 198 down to 120 days. Of these 9 had attained ages from 191 to 198 days; 4 had reached 190 days; 3 from 183 to 189; 38 were 180 days old; 3 from 174 to 178; 5 from 165 to 168; 1, 158; 8 of the age of 150 days; and 5, various ages from 120 to 147 days. Out of the large group of cases of infants born at 180 days, we find that 18 of the number survived their birth from 5 minutes to 16 hours; 6 lived one day; 3 from 5 to 11 days; 1, six weeks; 2, four months; and the remainder (7 in number) 1 year, 2 years, and 15 years respectively. Of the 8 infants of the reputed age of 150 days, 2 barely lived, two lived 3 minutes, one, 2 hours; one, 24 hours; one, 6 days; and one, 19 years. The group of five cases born prior to the 150th day comprises one of 120 born alive; one of 125 surviving 6 hours; one of 147, living 12 hours; one of 133 (Rodman's case), 21 months, and one of 135 (Capuron's case of Fortunio Liceti), living to 80 years of age!

2. The second class comprises the three leading cases by Rodman, Outrepont, and Belloc, which will presently be more closely examined. Of the facts of the first order it may suffice to state that there is nothing in the accompanying history of weights and measures which militates against the authors' estimate of the period of gestation at which the several infants had arrived; while, on the other hand, in the Jardine case, the weight of 3 lbs. stated to belong to a child born at 174 days, or before the completion of the 6th month, is a pound in excess of the highest weight of any of the five infants in the first group. It also exceeds the weights given at p. 70, with the exception of the very doubtful instance of 3 lbs. 13 oz.

But small length and weight are, at the best, but two signs of immaturity among several which are at least equally deserving of attention, such as the high position of the centre of the body, the disproportionate size of the head, and wide separation of the fontanelles; the presence of the membrana pupillaris; the non-descent of the testicles; the prominence and deep red colour of the parts of generation; the intense red colour, mottled appearance, and downy covering of the skin; the nails not formed; the scanty deposit, and total absence of sebaceous matter on the skin; the feeble movements and cries; the inability to suck, the

Lindsay Bonnar, M.D., Cupar, Fife: 'Edinburgh Medical Journal,' January, 1865.

necessity of artificial heat; the almost unbroken sleep; the rare and imperfect discharges of urine and meconium; and the closed state of the eyelids, mouth, and nostrils.

These, on the other hand, are signs of maturity:—

Strong movements and cries as soon as the child is born; the body of a clear red colour, and well coated with sebaceous matter; the mouth, nostrils, eyelids, and ears perfectly open; the skull having some firmness, and the fontanelles not far apart; the hair, eyebrows, and nails perfectly developed; the testicles descended; the free discharge of the urine and meconium a few hours after birth; and the power of suction, indicated by the seizure of the nipple or a finger placed in the mouth.

By comparing these descriptions with some of the more remarkable recorded cases, we shall see that there is reason to believe in the occasional survivorship of very immature infants. Of the three cases mentioned in group 2, the cases of Drs. Rodman and Outrepont are deserving of special consideration.

Dr. Rodman, after describing the mother as "cautious," "accurate," and trustworthy, and stating that she had borne five children, and "was confident that the period of her gestation was less than nineteen weeks," says, that premature labour was brought on by fatiguing exertions, and that she was delivered of a living male infant.

Not daring to wash the child, it was quickly wiped and wrapped in flannel, with only an opening near the mouth for the admission of air; and it was taken into the warm bed with the mother. Though the child was weak, no feeding was attempted till after the lapse of twelve hours. "The nourishing heat with the mother in bed was relied on." The next day, the head, body, and extremities were surrounded with fine cotton-wool, pressed like cloth, to the thickness of two or three folds, and over that the flannel as before; and again the child was given to the mother in bed. Even with this dress, he could not be kept warm enough; and as he soon became weaker when exposed to the heat of a fire, whilst the warmth of the mother enlivened and strengthened him, he was kept warm, by the mother and two other females lying in bed with him by turns for more than two months. After this he could be left alone from time to time, but was still undressed very cautiously. It was not till he was three weeks old that the length and weight of the body could be ascertained. The *length* was found to be 13 *inches*, the *weight* 1 *lb.* 13 *oz. avoirdupois.* It was extremely difficult to get the child to swallow nourishment the first week; the yellow gum soon came on, and the thrush seized him severely on the eighth day,

and lasted till the end of the third week. During the first week he was fed with two or three teaspoonfuls of toasted bread boiled with water, sweetened and strained through fine linen; in the second week twenty drops of beef-tea were added, and small doses of castor-oil were administered. At the end of three weeks he began to swallow teaspoonfuls of his mother's milk, and two days after made efforts to suck. The mother's milk was gradually substituted for the panada, which was still given occasionally with a few drops of port wine. Under this careful management he attained the age of four months, and his health and excretory functions were peculiarly regular. Five months after this, as we find from a second paper by Dr. Rodman,* this child was still doing well. In this paper he describes the mother as tall, robust, and healthy, and again states that she had a peculiarly accurate knowledge of the time of her previous gestations, and did not hesitate still to affirm, that the period in this instance was rather under nineteen weeks.†

Dr. James Hamilton, in his evidence in the Jardine case, states that this infant lived a year and nine months; but that from circumstances mentioned to him by Dr. Rodman, he had always thought that there was some mistake in the woman's reckoning, and that the infant was a dwarf, being considerably smaller than those puny infants born within the six months, whom he had seen drag on a miserable existence for four or five days.

It must be admitted that, in this instance, an extremely feeble and immature child was reared by very judicious treatment, and that the mother's estimate of the age was at least as likely to be correct as such estimates ever can be. The length and weight of the child, too, are in keeping with the other lengths and weights given at p. 67, and they will be found to coincide with the extreme weight and length of the tables at pp. 70, 71. The absence of any description of the appearances presented by the child prevents us from determining its degree of immaturity. It might have been a five months' child, but there is no ground for supposing it to have been born before the completion of the fifth month.

The case related by Dr. Outrepont, of Bamberg, is very valuable, for it is the only quite unequivocal instance on record of the rearing of a six months' child. The particulars are given so fully, and with such precision, that even Henke, who previously

* 'Ed. Med. and Surg. Journal,' vol. xii.

† Case of a child born between the fourth and fifth month, and brought up. By John Rodman, M.D., Paisley. 'Ed. Med. and Surg. Journal,' vol. xi. p. 445. The facts of this case were attested by Mr. White of Paisley.

denied the possibility of such an incident, candidly admitted that Outrepont's case is an unequivocal example.* The evidence is complete both as derived from the date of impregnation, and from the structure and history of the child. The mother, a young woman, who had always been perfectly regular, menstruated as usual ten days after her marriage, and was subsequently repeatedly connected with her husband. About a fortnight after this menstruation, she became changed in appearance, and, for the first time in her life, had frequent attacks of vomiting and fainting. These symptoms continued, but the catamenia did not return: and about twenty weeks after their last appearance, she felt the first movements of the child. Five weeks after this she was seized with labour-pains and hæmorrhage; and Dr. Outrepont, having ascertained that this proceeded from the placenta being attached to the os uteri, encouraged the labour, and brought it to a prosperous conclusion. The evidence of this child being not more than twenty-five weeks old, is as strong as it is reasonable to expect. The state of the child at birth was still more unequivocal. It was a boy, and breathed immediately on being born; measured thirteen and a half inches, and weighed one pound and a half. Its skin was covered with smooth lank down, and was much wrinkled. The extremities were extremely small in proportion to the trunk, and were kept constantly bent over the body, as in the fœtus in the womb. The nails of the fingers and toes were like white folds of skin, the testicles were still within the belly, and the pupillary membrane was entire. The child whined, but could not cry; slept almost constantly; awoke only once a day; seldom opened its eyelids, and was obviously insensible both to light and sound. The first discharge of urine took place on the seventh day, and the first evacuation of the bowels on the ninth. Subsequently the urine was voided once in forty-eight hours, and the fæces every two or three days. The child was placed in a basket filled with wool, kept in a uniform temperature, and moved with great care. For some time it was fed with the spoon on diluted milk and sugar. In four weeks the down began to drop off from the skin. In fifteen weeks the wrinkles had disappeared from the skin, and the length was increased an inch and three quarters. From this time, which corresponded with the fortieth week after impregnation,—that is, with the full period of utero-gestation,—it made rapid advances; sleeping less, eating more, crying strongly, and becoming evidently sensible to sound, and pleased with the light. When fourteen months old, it was of

* 'Zeitschrift,' vi. 27.

the weight and stature of a child born at full term. In the eighteenth month, the testicles descended into the scrotum. The teeth began to appear early in his third year. He did not begin to walk till half a year later; and then differed from other children of the same age, not only in size, but also in the singularly old expression of his countenance. When Dr. Outrepont saw him in 1816, he was eleven years of age, was as big as a boy of seven or eight, and had just begun to read and write.*

In this case also the length and weight are in keeping with the lengths and weights given at p. 68, and much within the extremes given in the tables at pp. 70, 71; and the signs of immaturity are so well marked and so minutely described as to be decisive of the possibility of rearing a child born before the end of the sixth solar month, or 26 weeks.

III. SUPERFŒTATION.

Superfœtation means the conception of a second embryo during the gestation of the first, the products of the two conceptions being born either at the same or at different times. Some light is thrown upon this question by more than one well-authenticated case in which a woman has been delivered of twins of different colours, both fully formed. The following are taken from many similar ones quoted or referred to by Beck:—A female at Charleston, in South Carolina, was delivered in 1714 of twins, within a very short time of each other. One was black, and the other white. She confessed that on a particular day, immediately after her husband had left his bed, a negro entered her room, and by threatening to murder her, had connection with her. This case is related on the authority of Buffon. Dr. Moseley mentions the following as occurring within his time at Shortwood estate, in the island of Jamaica:—A negro woman brought forth two children at a birth, both of a size; *one a negro, the other a mulatto.* She explained the occurrence by stating that she suffered the embraces of a white man belonging to the estate directly after her black husband had quitted her. A case of triplets of three different colours may be omitted as resting on insufficient authority.

These are cases in which the two mature children are brought into the world differing in nothing but colour from children of one father and one conception. There is another class of cases equally easy to believe and understand, in which the birth of two

* This case is taken from Dr. Christison's evidence on the Jardine case, with alterations and additions suggested by the perusal of the case in the 'Zeitschrift für die Staatsarz,' vi. 19. It may be well to state that Dr. Christison admitted the possibility of a child born after 174 days being reared.

children is separated by a short interval, or by an interval closely corresponding to their relative size and development, on the supposition of their being twins. Of the former class of cases the following, cited by Beck, from the *Consilia* of Zacchias, is an example :—J. N. Sobrejus lost his life in a quarrel, leaving his wife pregnant. Eight months after his death she was delivered of a still-born deformed child. Her abdomen remained large, and was supposed to contain a second infant, but the efforts made to procure delivery proved fruitless. One month and a day thereafter, the widow was again taken in labour, and brought forth a perfect living child. The relations of the husband contested its legitimacy, on the ground that it was the fruit of a superfœtation, and Zacchias was consulted. He agreed that the two infants could not have been the product of one conception, since the interval between their birth was so great: but gave it as his opinion, that the *first* was the product of a superfœtation, and conceived a month after the other. As the husband died suddenly while in a state of perfect health, his opinion preserved the character of the mother, and her legal rights. Zacchias seems, in this case, to have chosen the most improbable of two suppositions; for it is certainly more easy to suppose that the birth of twins, the product of the same conception, may take place at two different times, than that they should be the products of two different conceptions; and it is difficult to understand on what data he based his opinion that the child first born was the last conceived. In all such questions, the wisest course is to prefer that interpretation which involves the least difficulty, and is most consistent with experience. Now the expulsion of twins at different times is allowed to be a common event, of which examples are to be found in most works on midwifery. The most feasible opinion, then, seems to be, that this was a case of twins conceived at the same time, but of which one died, and was discharged, before the other.

But there are cases which do not admit of so easy an explanation, and which certainly countenance the theory of a double conception.

The wife of Raymond Villard, of Lyons, married at twenty-two and became pregnant at the end of five years, but had an abortion at the seventh month, on the 20th of May, 1779. She conceived again within a month; and on the 20th of January, 1780, eight months after her delivery, and seven months from her second conception, she was suddenly delivered of a daughter. This delivery was not, however, followed by the usual symptoms—no milk appeared, the lochia were wanting, and the abdomen

did not diminish in size. It was accordingly found necessary to procure a nurse for the child. Two surgeons who visited the female were at a loss with respect to her situation, and consulted Desgranges, who declared that she had a second child in the womb. Three weeks after her delivery she again felt the motions of a fœtus; the abdomen again increased in size, and on the 6th of July, of the same year, 1780 (five months and sixteen days after the first birth), she was again delivered of a living daughter. The milk now appeared, and she was able to nurse the child. Desgranges, after stating his firm conviction that these two children were conceived at an interval of some months, adds, that this second child could not have been conceived after the delivery of the first, inasmuch as no sexual intercourse took place between the husband and wife till twenty days after, which would have made the age of the second child only four months twenty-seven days.

On the 19th of January, 1782, the mother presented the two children, with extracts from the baptismal register, before two notaries of Lyons, in order to attest the facts above stated.*

Assuming the facts of this case to be correctly stated, it must be admitted to be nearly conclusive as to the possibility of superfœtation; for if we deny this, and assume both children to have been the product of a simultaneous conception, and the last child to have been at full term, the first, which, be it observed, in common with the other survived its birth between one and two years at the least, must have been born alive at three months and a half: or, if the first child be admitted to be seven months old, the second must have been born alive at six weeks. The alternative supposition, that the second child was the fruit of sexual intercourse subsequent to the delivery of the first, is also in the highest degree improbable, for it supposes a child, born before the completion of the fifth month, to be reared, and that without any difficulty. The only remaining supposition, namely, that the second child was a twin born after a gestation of twelve months and a half, presents equal difficulties.

Dr. Maton has also related a well-authenticated case, in which two male children (both "born perfect") were brought forth at an interval of nearly three calendar months. If this had been a case of simultaneous conception, the age of the one would have been six months or less, that of the other nine months or less.

Additional cases are referred to by Beck, in three of which there was an interval of one month, in two an interval of two months, and in one an interval of four months; and Dr. Bonnar

* Foderé, vol. i. p. 485.

cites Velpeau for a case in which an infant "thought to be at full time," was born five months after "a child at the *full time*."

In deciding this question, those cases only must be admitted to have any weight in which the interval between the births is considerable; for, where the interval is short, if we suppose the child last born to be mature, the first may have been eight or seven months old, which is quite reconcilable with the supposition of its being reared. When, however, the interval is one of four months, if we assume, as before, that the child last born is mature, the first cannot be more than five months old, an age at which it is in the highest degree improbable that a child could be reared at all, and certain that it could only be saved by ingenious and careful contrivances of which mention is sure to have been made.

In any cases that may hereafter occur, it will be important to observe the size and development of the children. But it must not be forgotten that even the healthy products of the same conception may differ greatly in size.

This fact is well illustrated by a case brought under the notice of the author by Mr. Streeter, in which female twins, five and a quarter months old, were born enveloped in a common chorion. The one was more than twice the size of the other, but the smaller alone had made successful efforts to respire.

If the single case of the wife of Raymond Villard be correctly stated, the doctrine of superfœtation must be admitted to be established; but it may be useful to subjoin the chief arguments employed by the advocates and opponents of that doctrine.

The opponents of superfœtation allege that the occurrence is impossible, because 1, shortly after conception the os tincæ, as well as the internal apertures of the Fallopian tubes, are closed by a thick tenacious mucus. 2. The membrana decidua, which is also formed soon after conception, lines the uterus, and aids in obliterating the openings into its cavity. 3. When the uterus is impregnated, the Fallopian tubes, instead of running horizontally to the ovaria, lie parallel to its sides, so that if a second embryo were formed within the ovarium, the tubes could not embrace and convey it to the uterus. And 4, that the new embryo would destroy the first.

The last objection is founded upon a bare assumption, and may therefore be summarily dismissed. The third objection, if valid, must prove fatal to the doctrine of superfœtation; but though this obstacle may exist in the fully-developed uterus, the ovary and Fallopian tubes are not more prevented from coming into contact with each other in the early stage of utero-gestation, at

which alone superfœtation is alleged to take place, than in the unimpregnated state. The answer to the first two objections is obvious. Neither the tenacious mucus nor the newly-formed decidua, though in contact with the orifices and cells of the uterus, adheres so firmly to it as not to admit the passage of the semen. The fact of menstruation in numerous cases occurring during a part or the whole of pregnancy seems to prove, that the adhesion of this tenacious mucus and of the decidua is by no means so firm as to forbid the passage of fluid; and this argument is strengthened by the frequent occurrence of hæmorrhage in the advanced stages of pregnancy in consequence of partial detachment of the placenta. The arguments advanced against the doctrine of superfœtation are therefore not of sufficient weight to counterbalance the improbabilities set forth in the case of Raymond Villard; and unless that case can be shown to be untrustworthy, there seems to be no alternative but to admit the truth of the doctrine.

If, then, we admit the possibility of superfœtation, the question arises, Can we explain this occurrence so as to avoid the objections of its opponents? The existence of double uteri, and more rarely of double vaginæ also, suggests the required explanation; and as the recorded cases of this malformation are much more numerous than those of superfœtation, it is quite possible that some of the latter may be explained by the malformation in question.*

That this malformation does really explain some cases of superfœtation, is proved by a case related by Scheider of a woman who, six weeks after marriage, bore a four months' child, and forty weeks after marriage mature twins. On examination, the uterus and vagina were both found double, and each vagina had a separate orifice.†

Dr. Bonnar, in the Essay already referred to, raises a novel question of much interest in itself, and obviously admitting of practical application, namely, how soon after her delivery may a woman again become pregnant. Starting from the common assumption that at least thirty days must elapse before the uterus can resume its generative function, and adding 274 to 280 days for the period of gestation, it would follow that no woman could bear a mature child sooner than the 304th, or from that to the 310th day. Dr. Bonnar, by referring to Lodge's 'Peerage and Baronetage,' shows that there have been at least 19 recorded

* Dr. Cassan ('Recherches sur les Cas d'Utérus Double, et de Superfœtation') has collected 41 cases, in three of which both uterus and vagina were double; and Beck has added 11 others, in three of which the vagina was double.

† Müller's 'Archives,' 1836, and 'London Med. Gaz.,' vol. xx. p. 408.

cases, in which the interval between one birth and another has been 309 days or less. There were 10 cases of 309 to 300 days; 2 of 299 to 290; 4 of 289 to 280; 1 of 273; 1 of 252; 1 of 182; 1 of 173; and one of 127 days. Dr. Bonnar, taking these cases into consideration, and weighing the facts relating to the state of the vagina, uterus, and lochial discharge, fixes on the *fourteenth* day after delivery as the earliest at which a fresh impregnation may take place.

Having discussed at length the three leading questions connected with the subject of legitimacy, it will be necessary to say only a few words on some questions of less interest and importance.

The question of paternity, as has been already stated, may arise where a woman, soon after the death of her husband, marries a second time. Sometimes this question assumes the shape of the one last discussed. A child is born within five months, or thereabouts, of the death of the first husband, and the question of paternity becomes one of viability. Where the child is of such an age as that it might have had either husband for its father, the question of paternity must be decided by a reference to the state of health of the deceased husband at the presumed time of conception.

Another class of questions, of little importance and rare occurrence in this country, may arise in slave-holding states, where the reputed parents of a child are of different colours, and the offspring differs in appearance from the majority of children of mixed marriages.

Some discussion has taken place as to the kind and degree of evidence of live-birth which may be necessary to establish a right of inheritance under the tenure known as 'tenancy by the curtesy.' "When a man marries a woman seised of an estate of inheritance, and has by her issue born alive, which was capable of inheriting her estate. In this case he shall, on the death of his wife, hold the lands for his life, as tenant by the curtesy of England." It appears that the meaning of the expression *born alive*, is not the same in this case as in cases of infanticide. It has been decided that in questions of tenancy by the curtesy, any kind of motion is evidence of live-birth. Thus, in the case of Fish *v.* Palmer, tried in 1806, "a twitching and tremulous motion of the lips" was held to be sufficient evidence of live-birth.

The question how far monsters are capable of inheriting, has been raised, and answered by Blackstone, who states that "a monster which hath not the shape of mankind," "hath no inheritable blood;" but if, in spite of deformity, "it hath human shape it may be an heir.

CHAPTER IV.

LIFE-ASSURANCE. FEIGNED DISEASES.

LIFE-ASSURANCE.

THE medical man performs important functions in relation to life-assurance. With the exception of the simple facts which the actuary obtains from mortuary registers as data for calculating common average risks, almost all information respecting special risks, and the causes which affect the duration of human life, must be drawn from medical sources.

Our assurance offices, moreover, employ medical examiners to report on the health of applicants, and their ordinary medical attendants are consulted respecting the diseases from which they may have suffered. The services of the medical man are still more indispensable in the case of those offices which undertake the insurance of unsound lives, and they are occasionally in request to report on injuries sustained by persons assured against accident. Medical men are also employed by benefit societies to examine persons applying for admission into them, and they are occasionally called upon to examine emigrants and recruits.

The insurance offices provide the medical examiner with a printed list of questions, prepared under medical advice, or suggested by their own experience, relating to the state of health of the applicant, his family and personal history, his occupation and habits, the diseases which he has suffered, and such other particulars as are presumed to affect the probable duration of his life.

Hence the duty of the medical examiner resolves itself into a work of inquiry and a work of personal inspection and examination, respecting both of which a few practical suggestions may be offered with advantage.

The inquiries which the medical examiner is expected to make relate partly to the family, and partly to the personal, history of the applicant. The importance of the first class of inquiries rests upon the ascertained prevalence of hereditary predisposition, whether of a favourable or unfavourable character. As a general rule, the children of those who have died at an advanced age themselves live to be old, while, on the contrary, the children

of parents who have died young are likely to be short lived. Moreover, many diseases which sensibly affect the duration of life are transmitted from parent to offspring, or, passing over one generation, from grandsire to grandson. The medical examiner should, therefore, ascertain whether the parents of the applicant are living or dead: and, if living, what age they have attained, if dead, at what age they died. This inquiry should be extended to the brothers and sisters, and in some instances to the uncles and aunts of the applicant. As a general rule it will not be necessary to extend the inquiry beyond the father and mother and the brothers and sisters, if the answers respecting them prove favourable; but if these near relations have died early, or if they appear to be subject to some hereditary malady seriously affecting the duration of life, it may be necessary to include in the inquiry a larger circle of relationship. Having ascertained the ages of the living and deceased members of the applicant's family, the examiner should next inquire into the causes of death in the case of those deceased members who have not died of old age. If one or more should be found to have died of pulmonary consumption, asthma, insanity, gout, or disease of the heart; or of apoplexy or dropsy at an early age; the fact would have to be noted as more or less seriously affecting the value of the life under examination; and similar importance would attach to the ascertained prevalence of any of these diseases among the living members of the applicant's family.

The personal history of the applicant would comprise his age, social relation (whether married or single), occupation, place of residence, and habits of life, and the diseases to which he has been subject, not forgetting to ascertain whether he has had small-pox, or been vaccinated. Among the diseases or symptoms of disease to which the greatest importance attaches may be mentioned spitting of blood (as affording a strong probability of consumption); gout, acute rheumatism, and asthma (both as liable to recur and as laying a foundation for serious organic changes); dropsy (as a common result and indication of severe organic mischief); inflammation of the lungs (as leaving behind it some unfavourable change in those organs, or as being the direct consequence of tubercular deposit); fits (as betraying serious lesion of the nervous system); rupture (as involving danger of strangulation); and calculous disorder (as obviously tending to shorten life).

The personal examination will have to be conducted with greater or less care and minuteness as the family and personal history have proved favourable or otherwise. If favourable, a cursory inspection and examination will suffice, and if the person is well

formed; the complexion healthy; the pulse regular and equal, of fair force, and not exceeding 70 or 75, or falling much below 60 (in the female not more than 80); and if the breathing is free and tranquil, the life may be safely recommended for acceptance. But if the family or personal history is unsatisfactory; if the person is ill formed or disproportioned, if the pulse is frequent or otherwise abnormal, and the respiration unnatural, and especially if the applicant has been attacked by any serious disease, a more minute examination directed to the condition of the nervous system, of the lungs, or of the heart, will be required. In examining the chest, percussion and auscultation should be employed, and in examining the lungs the spirometer of Dr. Hutchinson may be used with advantage.*

To these observations on the duties of the medical examiner a brief summary of our knowledge of the influence on longevity of place of residence, change of climate, occupation, and habits of life, of peculiarity of constitution, of hereditary predispositions, and of pre-existing disease, will now be added.

Place of Residence.—The principal facts that have been ascertained respecting the residence of persons living within the limits of their native country are the following:—1. That the inhabitants of the rural districts are longer lived than the inhabitants of towns. 2. That large cities are more fatal to life than small ones. 3. That marshes, and low-lying districts on the banks of rivers, are less healthy than more elevated spots. 4. That of two districts of equal elevation, that which has a sandy or gravelly soil is healthier than that which consists of clay or rich alluvium. 5. That close, damp, and ill-drained houses are peculiarly fatal to life. Such considerations as these ought, in extreme cases, to influence the examiner in selecting lives for assurance.

Change of Climate.—The removal from a temperate or cold climate to a hot one affects the duration of life much more seriously than any change of residence from one part of a man's native country to another. Our insurance offices, accordingly, either refuse to assure lives at all in extreme cases, or demand additions to the usual premium, varying with the ascertained or estimated increase of risk. The best information we possess in reference to this subject is drawn from the reports of the mortality of our troops and seamen employed in different parts of the world; from which it appears that while the difference between low damp situations and dry elevated ones prevails in every part

* For a description of this instrument, with directions for its use, tables of reference, and the indications which it affords, the reader may be referred to Hooper's 'Physician's Vade Mecum.'

of the world, the risk to life increases with the temperature, attaining its maximum within the tropics, and falling to the standard of England, or even below it, in cold or temperate regions. Some assurance offices, acting upon this general principle, allow the assured to reside without extra charge in any part of the world beyond thirty degrees from the equator, requiring from those who take up their abode within these limits an extra payment roughly proportioned to the additional risk.

Occupation.—The occupations which shorten life are those that lead to excess in spirituous liquors; those that combine sedentary habits, or a minimum of exertion, with exposure to a close and heated atmosphere; those that entail undue exposure to the weather, with hardships and privations; those that require long hours of work, and a sacrifice of natural rest; those that are carried on in clouds of dust; and those that bring men in constant contact with poisonous substances. The employments which demand special mention, as belonging to these several heads, are licensed victuallers, potboys, and brewer's draymen; compositors, tailors, and drapers' assistants; soldiers and sailors during active warfare; bakers; knife and needle grinders; house-painters, manufacturers of cards enamelled with lead, and men who work with mercury, phosphorus, or the salts of arsenic. One occupation not easily brought under any of these heads has been shown to shorten life without causing an undue amount of sickness, namely, the employment of the butcher.

The most important of the above employments, in its bearing on life-assurance, is that of the licensed victualler, whose life is very generally looked upon with suspicion, and even deemed uninsurable, in the absence of very distinct proof of temperate habits.

Habits of Life.—Luxury, sloth, dissipation, and intemperance, are very fatal to life; but the last is the only one of which it is easy to obtain distinct proof. When the fact of intemperance is clearly established it affords ground for peremptory rejection. It is also well ascertained that unusual risk attends the assurance of the lives of persons living in a continual state of pecuniary embarrassment.

Peculiarity of Constitution.—Under this head it will suffice to notice the scrofulous constitution; the long neck and narrow chest so common in consumptive patients; and the short neck, florid complexion, large chest, and tendency to corpulency of the victims of apoplexy.

Hereditary Predisposition.—The most important in relation to life-assurance is pulmonary consumption, a disease which

destroys one in seven of the entire English population, and more than one in four of the adults of the metropolis, being peculiarly fatal to men following sedentary occupations, and to persons of dissipated and intemperate habits. The inquiries of the medical examiner should be especially directed to discover traces of this disease in the family history, and great importance should be attached to the occurrence of several deaths from this cause among the nearest relatives. Insanity, gout, asthma, urinary calculus, disease of the heart, dropsy, and apoplexy, especially when they appear to have caused the death of more than one member of the family at a comparatively early age, are also deserving of serious attention.

Pre-existing Disease.—The medical examiner will have to form his own estimate of the influence which previous attacks of disease may have had upon the health of the applicant and the value of his life. As a general rule, it may be stated that the febrile exanthemata which make their attacks chiefly in childhood, and the typhus or typhoid fever of the adult, do not permanently affect the value of life. Attacks of erysipelas must be viewed differently, as this is a disease very apt to recur. The same remark applies to gout, acute rheumatism, and asthma, and in a very peculiar manner to pulmonary consumption, a disease which often proves fatal after several distinct attacks. The importance of the symptom of spitting of blood, as affording the probability of a previous attack of consumption, has been already insisted upon. The expectoration of a considerable quantity of vermilion-coloured blood would always warrant the rejection of a life; but a scanty expectoration of blood, whether light or dark coloured, should always lead to a minute and careful examination of the chest. If inflammation of the lungs, or other severe disease of those organs, or repeated attacks of bronchitis, figure in the previous history of the applicant, there would be the same reason for submitting the chest to careful examination; for these diseases are not only important in themselves, but may be the result of tubercular deposit, on the one hand, or may lay the foundation for mortal diseases of the heart on the other.

If the examination into the applicant's family and personal history, and his existing state of health, prove favourable, his life would be recommended for assurance on ordinary terms; but if unfavourable, the somewhat difficult question arises whether the life should be altogether rejected or accepted with a more or less considerable addition to the ordinary premium, or (what amounts to the same thing) on payment of the premium required for a healthy person of a more advanced age. Such adjustments

can only be safely made by medical men of experience and large medical knowledge.

But the medical examiner may be required to give his advice in reference to proposals for insurance on unsound lives for short periods, and to suggest the terms upon which they ought to be effected, for it may be of the utmost importance to effect an insurance for one or two years, on a life which must be rejected if offered for a longer term. A young person, for instance, who has already had symptoms of pulmonary consumption, and whose chest has been ascertained to be unsound, may desire to effect an insurance on his life for one year, and the examiner may have to report on the expediency of undertaking the risk; in which case he would be guided by some such considerations as the following:—Pulmonary consumption may prove fatal in any one of a long series of years, and the chances against an attack of the disease falling in any particular year are considerable; and even should it occur in the year covered by the assurance, there is the favourable chance of its commencing at a late period of the year, and either not proving fatal within the year, or (as the disease in its fatal attack has an average duration of nearly two years) not having a fatal issue till long after the period covered by the assurance has run out. Similar reasonings apply to other severe diseases, and, with little modification, to the assurance of unsound lives. On this branch of the subject, too, it is not possible to lay down any precise rules. To form a right decision large professional knowledge must be combined with sound judgment.

On the purely legal bearings of the subject of life assurance little need be said. It is obvious that the contract entered into in a policy of insurance may be rendered void by any intentional concealment or omission of such particulars of the previous health or habits of the applicant as, if known, must have caused the life to be rejected, or accepted only on more onerous terms; also by omitting to name the medical men who have attended him in any serious illnesses. But even where there has been no fraudulent concealment, questions have been raised as to the tendency of particular diseases, such as indigestion, gout, or mental unsoundness, of accidental injuries, such as fractures, and of particular habits, such as smoking and opium-eating, to shorten life. On all such questions there is much room for difference of opinion among even well-informed medical men.

The definite questions now commonly prepared for the guidance of the medical examiner, and the experience of the insurance offices of the difficulty of obtaining a verdict in their favour, except in cases of undoubted fraud, tend greatly to limit

the number of actions at law, and to deprive this subject of some legal interest which it formerly possessed. But its importance in every other point of view, and the value of the services of the medical examiner and referee, are increasing with the growing appreciation of the value of the assurance of life and health, and the consequent extension of the practice of insurance.

FEIGNED DISEASES.

Diseases and disabilities are feigned from a great variety of motives. The soldier or sailor pretends to be ill to escape from duty, or to obtain his discharge from the service, and the mendicant to avoid labour.

Sickness is often feigned to obtain parochial relief, or to impose on private benevolence; to defraud benefit societies; to procure the comforts of an hospital; to obtain compensation for some pretended injury; to procure a release from confinement, or exemption from punishment: and there are many persons, particularly young and unmarried females, who, without hope of gain, feign diseases in order to excite public interest and curiosity, or private sympathy.

The persons most prone to feign diseases are those who congregate most; as soldiers, sailors, prisoners, beggars, and school boys and girls. But the best school for feigned diseases is the army; and Foderé, speaking of the time when the conscription was in full force in France, says that malingering "was brought to such perfection, as to render it as difficult to detect a feigned disease, as to cure a real one."

In treating of feigned diseases a classified list will first be given of the principal diseases and defects which have been assumed; and this will be followed by rules for their detection.

It is difficult to form any classification of feigned diseases which shall be free from many objections. The most natural is into, 1. *Diseases and defects obvious to the senses;* 2. *Diseases and defects not obvious to the senses;* and, 3. *Diseases of a more complicated nature.*

I. DISEASES AND DEFECTS OBVIOUS TO THE SENSES.

This class contains the following subdivisions:—*a. Increased and diminished size of parts. b. Malformations. c. Wounds, ulcers, and superficial inflammations. d. Discharges. e. Spasmodic affections. f. Paralytic affections.*

a. Increased and diminished Size of Parts.—Tumours. A favourite mode of producing tumours is by injecting air into the

cellular tissue—beneath the skin of the abdomen to imitate *ascites*, into the scrotum to imitate *hydrocele* and *hernia*, under the scalp to give the appearance of *hydrocephalus*, into various parts of the limbs, with the help of ligatures, to imitate local swellings. The feel of such tumours having excited suspicion, the aperture through which the air has been introduced may be found generally covered by a small piece of plaster. Tumours are also produced by pressure. Swellings of the limbs, *anasarca*, *varicose veins*, and an appearance resembling *elephantiasis*, have been caused by ligatures; and *œdema* of the arm by hanging the limb over the back of a chair before the medical visits. Marks of the pressure are discoverable on careful search. *Tympanites* has been imitated by swallowing air, or drinking quantities of chalk and vinegar. A solution of Glauber's salts with weak tobacco-water has proved very efficacious in the hands of Dr. O'Hara. The appearance of an abdominal tumour has been produced by forcible protrusion of the spine. Tumours have also been imitated by the use of extraneous substances:—*polypus of the nose*, by the testes of a cock, or the kidneys of a rabbit, retained in the nostril, perhaps impregnated with fœtid juices. Strong sternutatories will unmask these cases. *Hæmorrhoids* have been imitated by the bladders of rats or small fish partly introduced into the rectum; *Prolapsus ani* by the gut of an ox or sheep, or by the everted anal extremity of the bowel of a colt or hog. In one case mentioned by Percy and Laurent, prolapsus was actually produced by passing into the bowel the bladder of a sheep, distending it with air, and forcibly retracting it. *Prolapsus uteri* has been imitated by similar means; *hydatids* of the womb by vesicles prepared from the intestines of a pig; *malignant tumours* by a sponge soaked in various colouring matters; and *hernia* by the injection of air, or the forcible retraction of the testicles towards the rings. *Cancer* has been imitated by a cow's spleen, and by a sponge moistened with milk, and fixed under the armpit. *Swellings of the joints*, intended to represent white swellings, have been produced by acrid plants, such as the ranunculus acris or sceleratus, applied to the part. Enlargement of the abdomen in the female has been simulated by a pad. *Partial atrophy* may be produced by pressure.

The frauds comprised under this head only require, for their detection, a careful examination of the part by the eye and by the touch.

b. Malformations.—*Lateral curvature of the spine* has been imitated, but always in the dorso-lumbar region. The curve is always single; the convex side not gibbous; there are folds of skin, generally two in number, on the concave side; and the haunch of

that side is raised so as to give the extremity the appearance of being shortened. Disease, on the contrary, occupies different parts of the spine; there is more than one curvature; the convex side is gibbous; the folds of skin, if present, are slightly marked, and there is little or no inclination of the trunk, or elevation of the haunch. *Gibbosity*, or *elevation of the shoulders, wry neck, hip-disease*, and *contractions of the limbs or joints*, are imitated by long-continued flexion, aided by inaction and the use of tight bandages. The contraction is either attributed to a burn or previous injury, in which case a wound is made to bear out the assertion, or to a previous attack of rheumatism. In these cases suspicion is excited by the absence of cicatrix, and of atrophy of the limb, and the presence of hardness and swelling of the contracted muscles. The means proposed for the detection of these impositions are:—pressure on the nerves supplying the contracted muscles; application of a wet bandage tightly round the limb, which, when dry, may compress the muscles; moving the limb during natural sleep; examining the limb during the sickness and weakness produced by an emetic, or by intoxication, or, better still, under the influence of chloroform; the electric shock; gradual and repeated tension by a pulley or weights; making sudden extension while the attention is engaged; the actual cautery, if that remedy be indicated in the real disease; or recommending the warm climate of the coast of Africa as a cure. In some cases the most effectual method is to treat the deformity as a matter of no importance, not requiring surgical treatment. *Dislocations* may be produced intentionally. Those of the shoulder-joint and patella are most easily accomplished. *Fractures*, when real, are prevented from healing by frequent motion, causing the formation of false joints.

c. Wounds, Ulcers, and Superficial Inflammations.—*Mutilation* is a common practice in the army, especially in regiments submitted to very strict and harassing duties; and in countries where the conscription is in force. *Wounds.*—The distinction between wounds as they are self-inflicted, inflicted by others, or accidental, will be considered under the head of wounds. *Bruises* have been imitated by colouring materials, but, not being true to nature, are easily detected by the experienced eye. *Ulcers* are among the most common of feigned diseases, and, when they exist naturally, are often intentionally increased. The means resorted to are corrosive acids and alkalies, caustics, corrosive sublimate, arsenic and its sulphuret, copper wire, acetate of copper, blistering plaster, quicklime, the flame of burning bodies, the ashes and chewed leaves of tobacco, the vegetable acrids, especially the

ranunculus acris and sceleratus, the mezereon or spurge-laurel, the euphorbium, the arum maculatum, and the juniper. Ulcers are also excited by mechanical means, as by the pressure of copper coin, and friction with sand. Occasionally ulcers are imitated by gluing part of a spleen or the skin of a frog on the part, and keeping the surface moist by a sponge dipped in blood and water. The lower extremities are the parts usually chosen for these tricks. Factitious ulcers may often be detected by careful inspection of the surface and dressings, or by a closer examination with the lens. The sudden increase of inflammation on and about the ulcer, and the healthy appearance of the impostor, will naturally excite suspicion. In hospitals, when an ulcer is supposed to be prevented from healing by the use of irritants, a wooden box completely enclosing the leg may be used with the best effect. *Fistula in ano and in perineo* have been imitated by inserting a tent covered with some irritating substance, or made of the root of the milk thistle, or white hellebore, into a punctured wound. *Cutaneous diseases* have been feigned, or intentionally produced:—*lupus*, by applying pounded garlic, or the juice of the euphorbium; *erysipelas*, by a short use of blisters; *urticaria*, by eating shell-fish; *psoriasis* and *impetigo*, by strong rubefacients; *pompholyx*, by blistering plaster; *scabies*, by punctures irritated with gunpowder; *porrigo*, by nitric acid dropped on the hand, as also by a paste composed of rancid butter, honey, sulphur, and powder of cantharides. *Baldness* has been effected by nitric acid. *Variola* in its eruptive stage has been imitated by bay-salt and gunpowder rubbed into punctures. The colour of the skin in jaundice has been imitated by several colouring matters.

To this division belong certain affections of the eyes obvious to the senses. *Ophthalmia* has been purposely excited by gonorrhœal matter, nitric acid, corrosive sublimate, sulphate of copper, nitrate of silver, lime, pepper, snuff, the smoke and juice of tobacco, salt, alum, the powdered root of euphorbium, a blast of cold air, cantharides, friction, and the introduction of sand, and fragments of cloth or muslin. The counterfeit disease is generally confined to one eye, and that the right: its progress is very rapid, the swelling and inflammation are chiefly in the conjunctiva, and cease when vision becomes imperfect. The eye is rarely so much disorganized as in the real disease. When it occurs in the army, it is apt to attack only the privates and non-commissioned officers. The use of irritants can often be detected, as in the case of ulcers, by simple inspection. *Ophthalmia tarsi* has been simulated by the use of strong irritants, or by the extraction of the eyelashes. A healthy aspect of the countenance would excite suspicion, as the

real disease rarely occurs in any but the scrofulous and cachectic. *Opacity of the cornea* has been caused by dropping a strong acid into the eye, or by introducing a fragment of lime or some other strong irritant. *Cataract*, too, has been produced by introducing a fine needle through the cornea to the lens.

d. Discharges.—*Vomiting* is effected by pressure on the pit of the stomach, by swallowing air, by a strong and sudden action of the abdominal muscles assisted by tickling the fauces, as well as by emetics. To provide suitable vomited matters, water, urine, and even fæces, have been swallowed. The larvæ of insects have been mixed with substances stated to have been vomited. Factitious vomiting is generally unattended by emaciation, and the other concomitants of the diseases of which it is a symptom. *Diarrhœa* and *dysentery*, too, are both feigned and excited; feigned, by mixing an ordinary evacuation with urine; excited, by a mixture of vinegar and burnt cork, by a solution of soap or sulphate of iron, by drastic purgatives, or by the introduction of irritating substances into the rectum. The evacuations are sometimes tinged with blood procured by puncture, laceration, or strong suction of the gums; or they are coloured of a dark red by logwood, green by senna, and black by deep-coloured wines. Careful examination of the evacuations, the use of a separate close-stool, the inspection of the linen, and a comparison of the symptoms present with those of the simulated disease, will assist in discovering the fraud. *Ascarides* have been clumsily imitated, as in an out-patient of King's College Hospital, by pieces of thread, one of which was red. A species of lizard was placed in the evacuations, in a case related by Dr. Spence. Alterations in the secretion of *urine* belong to this division. Alleged urinary concretions have been found to consist of sand, pebbles, and pieces of quartz and flint. Fragments of brick or slate, and small pebbles, have been introduced into the urethra to bear out the alleged existence of urinary calculus; and calcined bricks, coals, and fragments of bone have been inserted into the vagina with the like intention. Mere inspection assisted, in some cases, by chemical tests, will serve to unmask such impositions. *Hæmaturia* has been simulated by the use of beet-root, madder, cochineal, the Indian fig, the fruit of the prickly pear, and logwood; blood has also been injected into the bladder, or mixed with the urine after it has been passed, or it has been obtained from the urethra by scratches. It may also be caused by such drugs as savin, cantharides, and turpentine. The urine may be tinged of different colours by substances taken internally, such as madder, logwood, indigo, rhubarb, black cherries, the whortleberry, the pulp of

cassia fistula, elder rob, and ferrocyanate of potass, or of iron. Milk has been added to the urine to give it a white colour. In all suspicious cases, the patient should be made to pass urine in the presence of the medical man. The absence of the local and constitutional symptoms proper to affections of the kidney and bladder would naturally excite suspicion, and aid the diagnosis. *Gonorrhœa* has been imitated by the use of caustics; the *menstrual discharge* by staining the linen with bullock's blood; and *epistaxis* has been produced by incisions. *Hæmoptysis*, a favourite factitious disease, is imitated by holding in the mouth a bloody sponge, by incisions in the mouth or back of the throat, by pricking the gums, or by blood sucked from other parts of the body; also by pastilles coloured with carmine, Armenian bole, brickdust, or vermilion. In suspicious cases, the mouth having been carefully examined, and rinsed out with water, the rejected fluid should be inspected, and, if necessary, analysed: the chest also should be examined. *Hæmatemesis* is simulated by swallowing the blood of an animal. *Otorrhœa*, has been simulated by honey, pus, rancid tallow, assafœtida, or old cheese, placed in the meatus, and excited by cantharides, or by irritating liquids. *Ozæna* has been imitated and excited by similar means. *Fœtid breath and perspiration* have been produced by oil of dippel, assafœtida, old cheese, putrefying fish, and the rancid oil from a cart wheel. Ablutions, emetics, and close watching, will serve to detect these impositions.

e. Spasmodic affections.—These are frequently and successfully feigned. *Epilepsy* is the disease generally chosen, as it has the recommendation of being assumed at convenient times. In addition to the violent struggles which form the prominent feature of the true disease, impostors have inflicted bruises on different parts of their persons as evidence of former attacks, vomited blood previously swallowed, imitated the foam at the mouth by chewing soap, and discharged the urine as if involuntarily. As in the true epileptic seizure there is an entire absence of sensibility, the feigned disease is readily detected by any harmless infliction of pain, or by the use of some powerful stimulant, such as hartshorn, burning sulphur, snuff, or pepper, applied to the nostril; a few drops of alcohol or turpentine poured into the eye; a solution of mustard, or common salt, placed in the mouth; hot water, or actual flame applied to the skin. The skin has been pricked with sharp-pointed instruments without detecting the imposition. Of mechanical stimuli, the least objectionable, and most effectual, is the flecking of the naked feet with a wet towel or handkerchief. *Convulsions.*—

These have been rife in all ages, sometimes through involuntary imitation, sometimes as impositions, and more frequently in women than in men. The chief difference between the real and the feigned is, that the one may continue for a long time with little exhaustion, while the other soon occasions fatigue. To discover the fraud "it is sufficient to act with force on the antagonist muscles." (Orfila.) The impostor may also be tired out by long watching. Two of these cases have come under our notice: In one the muscles of the abdomen were the seat of the contortions; in the other those of the shoulders. *Chorea.*—This, like other convulsions, has been the offspring of fanaticism, of involuntary imitation, and of voluntary deception. When skilfully feigned the diagnosis is not easy, and many of the distinctions laid down in books are without foundation. Cold affusions and electricity, which may be used with propriety in true chorea, are not pleasant remedies for impostors, and are therefore to be commended. *Hysteria.*—It is of little consequence whether an attack of hysteria be feigned or not: cold affusion, which is the best remedy for the real disease, is not a pleasant application in feigned attacks. *Catalepsy* is very rare, and its existence, especially in a male, may fairly justify some degree of suspicion. Powerful stimulants, the proposal of the actual cautery while the finger is on the pulse, appending a weight to the extended limb and cutting the string suddenly, have been recommended and practised with effect in feigned cases. Unsuccessful attempts have been made to feign *tetanus and hydrophobia.* The fingers have been forcibly contracted, and the nails driven into the palm of the hand. By wearying the muscles with a conical piece of wood the imposition is readily detected. *Stammering* is often feigned. The best distinction is founded on the fact, that true stammerers hesitate little or not at all in repeating what they know by heart, and in singing. *Strabismus, nictitation, and blepharospasmus* are unimportant and easily pretended. *Dysphagia,* when feigned, may be cured by the persevering use of the probang. The suspected person should be narrowly watched. *Stricture of the urethra* has been feigned, but as the treatment of the real disease is not agreeable, the imposition is not likely to be persevered in.

f. Paralytic Affections (*Hemiplegia, Paraplegia,* and *Local Paralysis*).—In true palsy, the affected parts are relaxed and emaciated, and their temperature is lowered. In paraplegia, the urine generally undergoes a marked change. These characters are not present in the fictitious malady. Every form of partial paralysis has been feigned. In palsy of the fore-arm and hand,

the discovery of a blue line on the gums would give good ground for believing the paralysis real. *Paralysis agitans.*—In imitating this disease the impostor generally overdoes his part. It is considered characteristic of the real disease that the patient in attempting to walk "is impelled unwillingly to adopt a running pace." The pretender, on the other hand, hesitates in his movements and advances with difficulty. It happens fortunately that the remedies proper for real palsy are not agreeable ones; and where there is a good ground for suspicion, low diet will be found a useful auxiliary. *Ptosis.*—The impostor generally makes attempts to prevent the raising of the eyelid, and thus betrays himself. *Insensibility,* when feigned, may be detected by stimulants, and the imposition will often be discovered by inconsistent statements as to the cause. *Coma and lethargy* have been very successfully feigned, and in one or two instances the impostor has resisted every stimulant that could be thought of: in one case the operation of trephining caused merely a single groan. The treatment which we should be justified in resorting to if the complaint were real would prove a trying discipline to most impostors. *Syncope.*—This scarcely admits of being feigned, for if the impostor can contrive to grow pale, he can scarcely control the action of the heart and arteries. More than one case, however, of a voluntary control over the circulation is on record, of which the best authenticated—that of Colonel Townshend—will be found in the chapter on Real and Apparent Death. Poisoning has been feigned in some instances and imputed in others. Cases will also be given, under the heads of hanging and drowning, of the fraudulent disposal of a dead body so as that death may appear to have been due to those causes. Among prisoners unreal attempts at suicide by suspension or strangulation are very common. The attempt is usually made when assistance is known to be at hand. The feigned insensibility which follows is best unmasked by the electric shock.

II. DISEASES AND DEFECTS NOT OBVIOUS TO THE SENSES.

To this head belong, *a, increased,* and *b, diminished sensation.*

a. Increased sensation.—Pain. This is easy to assume and difficult to detect. External pains, such as tic-douloureux, often occur in persons otherwise, to all appearance, healthy; and there are severe pains, of which the cause is extremely obscure. Many cases are also on record in which acute pain has arisen from a cause that has escaped observation, and the sufferers have been treated as if it were assumed. The character of the pain, the

appearance of the patient, the presence of the symptoms of disease with which it is ordinarily associated, and the consistent account given of its origin and progress, will assist us in distinguishing real from pretended suffering. But great caution and patience are necessary; for remarkable cases are recorded of submission to the most severe and trying remedies, and even to the removal of the breasts and limbs for simulated neuralgic affections. *Pain in the head*, and the giddiness which often accompanies it, are also easily feigned, and not easily proved to be so. *Rheumatic pains* in every part of the body, especially in the loins and thighs, are often feigned; and, as they are not accompanied by any change in the parts affected, or by any well-marked constitutional symptom, with success. In many works on feigned diseases, long rules are given for detecting feigned pain, and the symptoms of almost every disease accompanied by pain are detailed with a minuteness as unnecessary as it is useless; for it may be stated as a general rule that feigned diseases of the more obscure class can be detected only by those who have extensive experience of real ones.

b. Diminished Sensation.—A diminution or entire absence of sensation is frequently pretended. *Amaurosis* is a favourite feigned disease, produced by the juice or extract of belladonna or hyoscyamus, the distilled water of the spurge-laurel, or snuff moistened with a decoction of belladonna. The amaurosis produced by these means disappears if the impostor be carefully isolated and watched. Of the perseverance with which the pretence of blindness is sometimes carried out, a case related by Mahon affords a good illustration. A recruit feigned blindness, and, after all other means had been tried without success, he was placed on the bank of a river, and ordered to walk forward, which he did. He afterwards confessed the imposture. *Myopia.*—Short-sightedness being a disability in the army is often feigned. It may be detected by placing an open book close to the face, or by requiring the suspected person to read print at some distance by the aid of glasses for the near-sighted. If the individual cannot read the book when thus placed, or when such glasses are used, we may be sure that the defect is feigned. *Presbyopia* is rarely feigned. The mode of detection is the converse of the preceding. *Amblyopia*, or weakness of sight, is also rarely pretended. In the army, the surest way to cure these pretended defects, is to employ the subjects of them in some service for which the real defect would not unfit them. *Nyctalopia.*—Night-blindness. This disease is peculiar to warm climates, in which the sun's rays have great power. There are no satisfactory means of distinguish-

ing the true from the feigned disease, as opposite states of pupil may exist in different cases. Here, too, it is useful to find for the real or pretended nyctalope some employment for which the affection, if real, does not incapacitate him. *Hemeralopia*, or day-blindness.—This disease is not of much importance. It sometimes occurs for a short time as a symptom of worms, or of other intestinal irritation. The diagnosis will depend upon our knowledge of the disease of which it is a symptom. *Deafness.*—As this may occur without any change in the appearance of the external ear, it is a favourite imposition. The modes of detecting it are obvious. A watch should be set on the suspected person day and night, and things calculated to excite interest or apprehension should be said in his presence, and the effect be carefully watched. It has been recommended to place the fingers on the pulse while any bad news, or threat of punishment, is being uttered. He should be called sharply or unexpectedly by name, or in a whisper, or he should be roused from sleep and spoken to, or a piece of money should be let fall close to him. All these and similar tests, have failed, and sometimes even the loudest noises have not produced any apparent effect. In one case, related by Dunlop, a pistol was fired off close at the ear without effect; but upon the man being sent to sleep by opium, the imposition was detected on the repetition of the firing. *Dumbness.*—This is sometimes assumed with great perseverance. As a general rule it may be stated, that if a man not deaf can move his tongue he is not dumb. Some add to pretended dumbness a feigned mutilation of the tongue, which they effect by rolling it back into the throat, and scratching it to make it bleed. A relative of the author's detected this fraud in the case of a man who, by a written paper describing his captivity among the Algerines and his mutilation by them, had excited great commiseration. Pretending to give entire credence to the man's tale, and taking a half-crown out of his pocket, he requested the man to show him his tongue once more, upon which he thrust his finger suddenly against the root, and the tongue rolled out. *Deaf-dumbness.*—The combination of deafness and dumbness, though never occurring in a person previously in possession of both these faculties, is sometimes obstinately pretended. In one or two remarkable instances, men who have pretended that they were born deaf and dumb, have resisted every test, and have been detected only by those having personal experience of the really deaf and dumb.

III. DISEASES OF A MORE COMPLICATED KIND.

In the two foregoing divisions those impositions have been

considered which consist of a single outward manifestation, tangible or visible to the senses; or of a single alleged symptom or defect, not necessarily combined with other symptoms to constitute a disease. It now remains to speak of cases in which whole trains of symptoms proper to certain diseases have been assumed, with more or less success. This division consists of two classes: *a. Diseases of the body.* *b. Diseases of the mind.*

a. Diseases of the Body.—Fever. Foderé states, that he has often seen impostors produce an extraordinary frequency of pulse, accompanied with chattering of the teeth and profound sighs. Febrile symptoms may be excited by strong stimulants, such as wine, brandy, cantharides; and by tobacco, which has a remarkable effect on the pulse; also by the introduction of a clove of garlic into the rectum. Violent exercise, or strong contraction of the limbs, or a heap of blankets, has been resorted to as a means of imitating fever, the tongue being whitened by chalk, pipeclay, soap, flour, or whiting; and tinged brown by tobacco, brick-dust, liquorice, or gingerbread. Pallor of the skin has been imitated by emetics, by smoking, by digitalis, or by drinking an infusion of cumin seeds. A flush, on the other hand, is produced by friction. The detection of cases of simulated fever is easy. The effects are always ephemeral, and all that is necessary is to have the patient watched for a few hours. *Ague* is often feigned, but not with much success. The effort to imitate the rigors throws the impostor into a perspiration, which leads to detection. The shivering fit is not followed by the other stages. Various affections of the *chest* are assumed by impostors. *Pneumonia.*—In one instance mentioned by Dr. Gavin this disease was assumed, but not very successfully. The stethoscope would serve at once to prove its non-existence. *Phthisis.*—It would be difficult to deceive a careful observer, or one skilled in the use of the stethoscope; but many symptoms of the disease have been successfully assumed. Hæmoptysis and mucous expectoration have been imitated in the manner already described. Emaciation may be produced by abstinence, by drinking vinegar, or by sucking a copper coin; febrile symptoms by the means just pointed out. *Asthma*, also, has been imitated, but here the stethoscope will assist in the detection of the imposition. *Apoplexy* cannot be successfully feigned. The fraud is easily detected by sternutatories, or by strong stimulants. *Dyspepsia.*—Vomiting, gastralgia, pyrosis, and in fact all the symptoms of dyspepsia have been assumed, and the imposition has been detected only by careful watching. *Gastritis*, or acute dyspepsia, has also been assumed, but not successfully. Constant vomiting is not easily

feigned, nor is the bright-red tongue, often present in acute gastritis. *Peritonitis*, too, has been imitated, but rarely with much success. In one case in which there was a pretence of great pain increased by pressure, a dose of opium was given, and the man bore very strong pressure without being roused from sleep. *Hepatitis* in its chronic form is a favourite feigned disease, as it is very prevalent in hot climates, and is supposed to be of very frequent occurrence in this country. The dull heavy pain in the right side is easily assumed, and the pain in the shoulder, but the discoloured eye and skin, the unhealthy aspect of the countenance, and the mental depression and listlessness not so readily. *Jaundice* has been imitated by staining the skin with an infusion of the root of curcuma longa, or of saffron, with tincture of rhubarb, the bruised seeds of the broom, or the stamens of the iris. Clay-coloured stools have been produced by taking a small quantity of muriatic acid, and the colour of the urine has been heightened by rhubarb. Attempts have also been made to pass off pebbles for gall-stones. It is not easy to tinge the conjunctiva yellow, nor to produce at one and the same time the yellow skin, the pale stools, and the high-coloured urine. It must be borne in mind, however, that in the real disease the fæces are not always pale, but that occasionally they contain an excess of bile. *Scurvy*.—One prominent symptom of this affection is often imitated, viz., the spongy and bleeding gums. For this purpose, various irritating substances are used, or the gums are punctured previously to the visit. As this is but one symptom, and the others are not easily feigned, this imposition will present but little difficulty. *Nephritis*.—The pain which accompanies this disease has been assumed, and the assertion has been borne out by the exhibition of pebbles or fragments of brick. It is scarcely necessary to state that it is almost impossible for an impostor to assume all the symptoms of nephritis.

Much more might be said on this division of feigned diseases, and minute rules for diagnosis might be laid down: but want of space, and the assurance that it is not by descriptions of diseases, but by actual experience of them, that the true are to be distinguished from the false, has led to the subject being thus briefly handled. Those who are familiar with treatises on this subject will know how much of false diagnosis they contain. In doubtful cases, a reference to the best description of the disease supposed to be assumed is strongly recommended, but it must be borne in mind that symptoms commonly considered as of high diagnostic value may be absent in the real affection, and may lead to unjust suspicions.

b. Diseases of the mind—Feigned insanity will be treated in the next chapter under the head of Unsoundness of Mind.

The following general rules may render some assistance in distinguishing a feigned disease from a real one.

RULES FOR THE DETECTION OF FEIGNED AND FACTITIOUS DISEASES.

1. Inquire into the existence of motives for deception. Will the suspected person, by imposition, gain anything he desires, or escape anything he dreads? It should, however, be borne in mind that both men and women feign diseases from other motives than those of gain; and that there may be so complete an absence of all discoverable motive, as to force us to believe in the existence of a moral insanity displaying itself in this way.

2. Inquire into the previous history of the patient, and the character he bears among his comrades or companions. It often happens that he has been previously noted for dishonesty, and for practices similar to those of which he is suspected. But men of the best character, who have for years conducted themselves with propriety, have been convicted of malingering.

3. In the case of external disease obvious to the senses, make a minute and careful inspection of the part itself, and examine it both by eye and hand. When there is a suspicion of the use of irritating substances, inspect the part narrowly with the lens, and search the pockets, boxes, or bed of the suspected party, and if necessary isolate him so as to deprive him of the assistance of others, and of his means of deception. Examine substances alleged to have been discharged, if necessary by the microscope or by chemical tests. In cases of rigidity, anchylosis, or deformity, place the suspected person under the influence of chloroform.

4. When some defect, or disability not obvious to the senses, but depending on the assertion of the person himself, as pain, deafness, &c., is supposed to be assumed, we must endeavour to take him by surprise. In pretended deafness, for instance, we must try the effect of sudden noises, or of speaking to the suspected person immediately on his being roused from sleep, or when his self-control has been impaired by opium or chloroform.

5. In cases of feigned diseases, properly so called, we must inquire minutely into the history and alleged causes of the disease; compare the age, temperament, and mode of life of the suspected person with the symptoms present; watch their course narrowly; and contrast it with the known march of the disease itself.

6. The suspected person should be visited at all hours of the

day, at times at which he does not expect to be seen; and he should be watched by those whom he is not likely to suspect.

7. The questions addressed to a suspected person should be of a nature to lead him into the assumption of symptoms foreign to the malady he is simulating. By concealing the suspicions really entertained, and foretelling in the hearing of the suspected person, the advent of symptoms which do not belong to the assumed disease, the malingerer may often be made to betray himself.

8. Ascertain whether the suspected person makes use of the medicines and measures prescribed for his relief. The impostor is less disposed to use them than he who is really ill.

9. Great caution is necessary in the treatment of suspicious cases. As a rule, no measures ought to be employed which would not be justifiable on the supposition of the disease being real. But when there is strong ground for suspicion, low diet, isolation, and nauseous medicines may be resorted to. When the disease supposed to be assumed is one which does not affect life (such as spasmodic twitchings of the muscles), it will often suffice to treat it with indifference, and to dissuade the suspected person from medical treatment. Persons who wantonly abstain from food will generally desist if allusion is made, in their hearing, to cases of prolonged abstinence; and those who refuse to take exercise may be influenced by being placed on a lower diet.

Closely connected with this subject is that of disqualifying diseases. It is chiefly interesting to military and naval surgeons; but the services of the medical man are occasionally required in civil cases. He may be directed to ascertain whether an individual is fit to serve on a jury; whether he is able to attend as a witness; whether he is competent to take on him certain offices or duties; or whether he can bear hard labour, or other severe punishment: also to ascertain the state of health of children presenting themselves for admission into our public schools. In this case, as in that of recruits, and of persons desirous of insuring their lives, the medical man must be on his guard against attempts to pass off the health as better than it really is, and to conceal defects and diseases actually existing. The subject of exemption on the ground of disqualification in civil and criminal cases scarcely requires, or admits of, any precise rules; and disqualification for military service is a subject of too great extent to be treated of in this place. There is the less necessity for its introduction here, inasmuch as the military surgeon is required to possess some work on his recruiting duties. The foregoing observations on feigned and factitious maladies apply equally to *malingerers* in the army and *skulkers* in the navy as to impostors in civil life.

CHAPTER V.

UNSOUNDNESS OF MIND.

THIS is a subject on which the medical man is often required to give evidence. A man makes a will; its validity is disputed: was the testator, at the time of making it, in full possession of his faculties? A man squanders his property, or is accused of so doing: is he competent to manage his affairs? Or he contracts an unsuitable marriage: could he give a valid consent to the contract? A criminal, or person under accusation, makes a confession: was his mind sound when he made it? An act of great atrocity is committed: was the perpetrator of sound mind and responsible for his act? A criminal is supposed to feign insanity that he may escape punishment: is he really of unsound mind? That these questions are of frequent occurrence may be inferred from the fact that there are about 50,000 persons of unsound mind in England; that the number of certified cases has been for many years past increasing at the rate of 1000 a year; and that the number of insane persons of all classes certainly exceeds the full estimated proportion for Europe generally of 1 in 500 of the population.

The medical man may be summoned to give his evidence in any of our courts of law, civil, criminal, or ecclesiastical; before commissions technically designated *de lunatico inquirendo;* and in the case of pauper lunatics, before a magistrate. He may also be called upon to sign certificates of unsoundness, at the instance of private persons, with a view to provide for the safe custody of those who are unable to take care of themselves, or are deemed dangerous to society.

All inquiries into the state of the mind are surrounded by peculiar difficulties—difficulties partly inherent in the subject itself, partly due to the requirements of the law, and partly also to the state of public feeling. The difficulties of the first order arise, in part, out of the original individual character of the mind, the degree in which it may have been developed by instruction, and the guidance and restraint to which it may have been subjected. Other difficulties inherent in the subject are to be found in the purely inferential character of our knowledge of

the mind, in the inapplicability to it of the method of experiment, in the want of any recognised standard of sanity, and in the necessity under which we lie of erecting our own mental experience into a standard to which to refer the minds of others. Minds thus differing in original power, and in acquired knowledge and habits, are known to be variously affected by the same physical and moral causes, and to be subject to many distinct forms of disease displaying themselves in language and acts of the most varied character. Some part of the difficulty that surrounds this subject is also to be traced to the undue importance formerly given, in treatises on the human mind, to one or two of its higher faculties. Reason and imagination were put so prominently forward, and the emotions and passions were made to play so subordinate a part, that soundness and unsoundness of mind came to be regarded as almost synonymous with a sound or erring reason; imagination had to bear all the blame of misleading the judgment; and delusion became the favourite test of insanity.

A more simple and practical theory of the human mind, recognising the existence of several distinct faculties, has now taken the place of the narrow speculations of the older metaphysicians. And this theory of separate faculties, originally of different power in different persons, more or less improved by instruction and education, under greater or less restraint from without or within, subject to different degrees of excitement from causes acting within the body or external to it, is the theory that agrees best with reason and experience, and offers the readiest explanation of the infinite variety of character, the endless diversities of opinion, and the strange eccentricities of conduct prevailing among mankind. It is also most in harmony with what we know of the unsound mind.

The second class of difficulties, or those due to the requirements of the law, originate in part from the lawyer's necessary inexperience of the unsound mind, the narrow views handed down to him, and the arbitrary selection of tests difficult, if not impossible, of application: also in part from his looking at questions of unsound mind mainly as they affect the liberty of the subject, or the safety of the State.

The difficulties of the third class, or those which arise out of the state of public feeling, are partly political and partly religious—political, inasmuch as the views expressed with respect to persons of unsound mind are regarded not as they are true or false, but as they may be thought to affect the well-being of society and the safety of the State; religious, because being

deeply impressed with the fallen and sinful nature of man, the most estimable persons are ever ready to trace strange thoughts and revolting acts rather to that original taint than to disease.

In discussing the subject of unsound mind, we must premise that it is not possible to frame a single definition of that state, nor to present a just view of it in one description. For mental unsoundness assumes many shapes, necessitating many divisions and subdivisions, with a corresponding nomenclature. In framing a fitting classification and nomenclature, it is well to adopt, as far as practicable, the divisions and names sanctioned by legal usage. Wherever, then, the law defines with precision the meaning of terms, those terms will be preferred; and where no fitting word has been provided, that will be employed which has already been accepted by the best medical authorities.

In the search after an appropriate nomenclature we first encounter the words "mad" and "insane," descriptive of the person affected; "madness" and "insanity," descriptive of the state of the sufferer. These terms might be at once adopted if they were commonly used as the exact opposites, respectively, of the words "sane" and "sanity." But they are generally employed in a restricted sense, applied chiefly to such deviations from the healthy state of the mind as consist in excessive activity, and rarely, if ever, to those states characterized by deficient energy of action, original or acquired. We must, therefore, seek for terms to which we may attach a more precise meaning. Such are "Unsoundness of mind" applied to the condition of the mind itself, and "Non compos mentis" applied to the person whose mind is affected.

But even these terms are not free from objection, for "Unsoundness of mind" has not always been employed by legal authorities in a strict and limited sense. In the Portsmouth case, for instance, Lord Eldon spoke of it as a state requiring to be distinguished both from idiocy and lunacy, and in many statutes it is found associated with the words Idiot and Lunatic.

The term "Unsoundness of mind," then, which seemed so simple and intelligible, is not free from objection: but as it is better than "Insanity," or any other phrase in common use, it is placed at the head of this chapter. The other term, "Non compos mentis," applied to persons of unsound mind, has been more consistently used by legal authorities, and ought to have the preference over all others.

Having thus chosen a term comprehensive enough to include all deviations from a sound state of mind, we must next inquire what the law includes under this term, *non compos mentis,* what

forms of unsoundness it recognises, and how far it may consist with our knowledge as medical men to adopt a subdivision in accordance with this legal usage.

The common law of England originally included under this term only two forms of unsoundness, Idiocy and Lunacy, but the highest legal authorities have seen the necessity of more minute subdivision. Thus Lord Coke recognised four sorts of *non compos mentis.*—"1. *Idiota,* which from his nativity by a perpetual infirmity is *non compos mentis.* 2. He that by sickness, grief, or other accident wholly loseth his memory and understanding. 3. A lunatic that hath sometime his understanding, and sometime not, *aliquando gaudet lucidis intervallis,* and therefore he is called *non compos mentis,* so long as he hath not understanding. Lastly, he that by his own vicious act for a time depriveth himself of his memory and understanding, as he that is drunken."

We have here distinctly recognised three forms of unsoundness, *Idiocy, Dementia,* and *Lunacy,* of which the first two are so well defined and understood as to admit of being used both by lawyers and doctors in classifying the forms of unsoundness. But the term *Lunacy* is objectionable, because it implies only that form of mania which is characterized by lucid intervals.

Since Lord Coke's time little has been done towards a better classification; though Lord Hale, in recognising a distinction between general, or total, and partial unsoundness, may be said to justify the separation of monomania from mania. If this be so, we shall find good legal authority for at least four forms of unsoundness—Idiocy, Dementia, Mania, and Monomania.

These four states, taken as varieties recognised by legal authority, may be expanded into a reasonable and serviceable classification by the addition of the forms or phases of unsoundness recognised by the best medical authorities at home and abroad. We must group the three well-known forms of Idiocy, Imbecility, and Cretinism, under some one heading, than which (though not free from objection) no better can be found than *Amentia. Dementia* must be made to comprise the acute and chronic, or primary and secondary, forms, as well as the peculiar state known as General Paralysis. And, lastly, *Mania* must be made to comprise not only affections of the intellect but those also of the emotions, and must recognise in both, a general and a partial unsoundness. The following tabular arrangement represents at one view the fulfilment of these conditions:—

UNSOUNDNESS OF MIND.

Amentia.	*Dementia.*	*Mania.*		
1. Idiocy.	1. Acute, or primary.	1. General (*Raving Incoherence*).		
2. Imbecility.	2. Chronic, or secondary.	2. Intellectual	General.	
3. Cretinism.	3. Senile Dementia.		Partial	Monomania. Melancholia.
		3. Moral . .	General.	
	4. General Paralysis of the Insane.		Partial	Homicidal. Suicidal. &c. &c.

This classification, be it understood, is adopted not as presenting a condensed philosophy of the unsound mind, but as a convenient index of the order in which this subject will be treated in these pages. Those who have actual experience of the insane will be the first to see that Cretinism is a condition which comprises both Idiocy and Imbecility, but with corporeal defects and malformations so peculiar as to require special notice; that, for a similar reason, Senile Dementia and the General Paralysis of the Insane, though involving a state of mind common to every form of mental decay, are deserving of a separate recognition; and, lastly, that Mania displays itself with such distinctness in all the forms specified in the table, as to justify all the divisions indicated.

As unsoundness of mind is a very large subject, and embraces many details, a methodical arrangement of it is absolutely necessary. It will accordingly be treated under the following heads:—1. Of certain states of the mind compatible with sanity, but illustrative of unsoundness—viz., illusions, dreams, and somnambulism. 2. Of certain states allied to unsoundness, and caused by disease, or the action of poisons—viz., delirium, delirium tremens, and drunkenness. 3. Of the several forms of unsound mind treated in the order in which they stand in the foregoing table. 4. Of the more important characters of the unsound mind, and of its medical and legal tests. 5. Of feigned unsoundness of mind. 6. Rules for the examination of persons supposed to be of unsound mind, and for the guidance of the medical witness in these cases.

I. ILLUSIONS, DREAMS, AND SOMNAMBULISM.

These phenomena have a close connection with, and direct bearing on, mental unsoundness. Spectral and other illusions are common in the insane; dreams are generally recognised as analogues of insanity, and the acts of the somnambulist may give rise to medico-legal questions.

Illusions.—A sensation without corresponding external object is called an *illusion*, when it occurs involuntarily. When called into existence by an act of the will, it is known as a *vivid perception*. When the eye is, or seems to be, the seat of the sensation, it is called a *spectral illusion*, *phantom*, or *phantasm*. The word *hallucination*, as the French use it, has the same meaning as our word illusion. It is not needed by us, and should be allowed to fall into disuse. Old English writers used it as synonymous with an error, mistake, or blunder; medical writers in the sense sometimes of an illusion, sometimes of a delusion. In the case of Buranelli, the medical witnesses were examined as to the proper meaning of the words *illusion* and *delusion*. There ought to have been no difficulty in defining them. The difference is best shown by adding three words to each:—an illusion of the senses, a delusion of the mind. An illusion means a mockery, false show, or counterfeit appearance; a delusion, a chimerical thought. It may be well to add that an illusion of the senses, if believed to be a reality, becomes a delusion of the mind. The word illusion may be applied, with equal propriety, to a sensation without corresponding object, to a transformed appearance of a real object, or to an internal sensation exaggerated or misinterpreted. It is improperly applied to real sensations, as of enlarged shadows projected on to masses of clouds, misinterpreted for a time through ignorance and superstition into the "Giant of the Brocken," sailing ships, and fighting armies. The use of the word *hallucination* has seemed necessary to those who wish to draw a line of distinction between illusion, pure and simple, and that which might well be called "illusive transformation." Thus Brierre de Boismont uses the term *hallucination* to designate an unreal sensation wholly due to the action of the brain; and *illusion* to designate a real sensation exaggerated or distorted by the same operation; and Griesinger, quoting Esquirol with approval, sanctions substantially the same distinction. Whatever terms, however, we elect to use, these four distinct conditions we ought not to confound the one with the other; a voluntary representation of an idea on an organ of sense, which is a vivid conception; an involuntary sensation, without corresponding object, which is an illusion; an equally involuntary transformation of a real object, which is also an illusion; and an actual vision (*e.g.*, a mirage) simply misunderstood and misinterpreted. It is to this last that the word hallucination, if used at all, should, in accordance with the usage of the best writers, be applied. It will not be used at all in these pages.

Illusions may occur as early as four years of age, in young and

middle-aged adults; and in octogenarians; some in perfect health, others suffering from trivial and transient indispositions, cured by such remedies as moderate depletion and simple aperients, others in the first onset of more serious diseases, inflammatory and febrile, or during the stage of convalescence. Illusions have also been produced by every form of arrested circulation through the brain, by many simple derangements of the same, by the inhalation of carbonic acid, or its generation within the body itself, and by many poisons of the narcotic and narcotico-acrid class, and notably by opium, alcohol, Indian hemp, belladonna, hyoscyamus, and stramonium. Illusions of sight (spectral illusions) are the most common; those of hearing come next in order; those of taste, smell, and touch, are more rare. In spectral illusions, which have been most studied, there are differences interesting to physiology, but of little practical importance.* But these two facts may be applied with advantage in the study of the unsound mind:—1. That these illusions occur in the irremediably blind, and that, in these cases, they must result from changes in the cerebral circulation, or of the brain-tissue. 2. That though, in some cases, they follow directly on an excited emotion, such as anxiety or fear, and may be attributed to an imagination responsive to it, in the greater number of cases, they are as involuntary as spasms or convulsions.

Now spectral and other illusions are of very common occurrence in some forms of unsoundness, and they serve to explain, in part, the obstinate belief by which the mind is possessed. Thus a religious maniac, the author of a most interesting autobiography,† strongly confirmed by statements made to us by persons who have been similarly afflicted, says, in reference to one of his many spectral illusions: "I imagined I was really present to *them;* and that my not acknowledging it was a delusion, an obstinate resistance of the Divine will on my part. That of the two, the appearance of the bed, walls, and furniture, was false, *not* my preternatural impressions."

Spectral illusions, then, may occur in persons of sound and of unsound mind, the difference being, that the former do not believe in their reality, the latter do. The sane man corrects these false impressions by the other senses, by an effort of comparison, or by appeals to others, while the man of unsound mind neglects these

* For cases in detail see Hibbert on 'Apparitions,' Sir David Brewster's 'Letters on Natural Magic,' Sir Walter Scott's 'Demonology and Witchcraft,' and Brierre de Boismont 'On Hallucinations.'

† 'A Narrative of the Treatment experienced by a Gentleman during a state of Mental Derangement,' p. 63.

simple means of undeceiving himself, or cannot use them; or, if he entertain any doubt, dispels it by the help of his delusion. Thus, the author of the autobiography thought it *impious* to doubt.

Dreams.—The phenomena of dreaming have a striking analogy to those of some forms of unsound mind. The external world being shut out, and the higher faculties and will being in a state of comparative inaction, illusions and delusions have the vivid impress of reality, and follow each other according to associations over which we have no control. Many dreams are directly traceable to conditions of the body, which in the waking state produce pain or uneasiness, such as fulness of stomach, distension of bladder, or irritation of the skin. Sometimes the sleeper is quite conscious of this uneasy sensation, and seems to be seeking relief in unlikely ways and places; at other times he attributes it to a wrong cause, and associates it with imaginary events. Thus a fit of indigestion is converted into *a nightmare,* and the ruffled dressing of a blister on the head suggests a dream of falling into the hands of savages, and being scalped by them. In other instances, the uneasy sensation gives rise to a dream which has no other relation to the sensation itself than that of being painful or disagreeable. In another class of cases, the bodily uneasiness seems to have no other effect than that of bringing the mind into a condition favourable to the blending together of disconnected occurrences, recent or remote, having nothing in common but the feeling of annoyance or discomfort. We hear of a distressing accident; we receive bad news of an absent friend; and we have been concerned in some anxious business: a dream combines these scattered elements; we are ourselves connected with the accident; the absent friend is in our company; and the person with whom the business is transacted also appears on the scene.*

Dreams excited by certain sensations are subject to a very strange law: a sound which wakes the sleeper, occasions a dream that appears to occupy a considerable time. Thus, "a gentleman dreamed that he had enlisted as a soldier, joined his regiment, deserted, was apprehended, carried back, tried, condemned to be shot, and at last led out for execution. After all the usual preparations, a gun was fired; he awoke with the report, and found that a noise in an adjoining room had both produced the dream and awakened him."

* The reader is referred to Dr. Abercrombie's well known work, 'Inquiries concerning the Intellectual Powers, and the Investigation of Truth,' for many instructive facts relating to this subject; and for more full information on the physiology of the human mind, to the chapter on Mental Physiology and Pathology in the author's edition of Hooper's 'Physician's Vade Mecum.'

The strong analogy that exists between dreams and certain forms of unsound mind, is shown in the examples cited at p. 164, and the passing of the one into the other, by the case of a maniac mentioned by Dr. Gregory, who for a week after his recovery was harassed, during his dreams, by the same rapid and tumultuous thoughts, and violent passions, by which he had been agitated during his insanity.

The case of M'Naughten may perhaps be cited as bearing a close resemblance to one class of dreams. The refusal of his father to take him into partnership originated in his mind a sense of hardship and injury: the Roman Catholics, the Police, and the Tories, being successively the theme of newspaper abuse, and being also represented as guilty of acts of injustice, impressed his mind with the same feeling. Hence the long dream of years, in which the sense of public injury was transferred to himself, till he became the fancied object of political persecution.

The difference between dreaming and insanity is, that in the one, the senses are closed to outward objects; in the other, the evidence of sense is disregarded, or the senses merely suggest trains of wild and fanciful association, illusions blended with objects rightly perceived being perverted and misinterpreted by the help of the prevailing delusion. As soon as the dreamer is roused from sleep, and the outer world is again brought before him, all his illusions and delusions vanish; but the madman is in a waking dream, from which he cannot be roused.

Legal relations of Dreaming.—A question of criminal responsibility arises in those rare cases in which a man suddenly roused from sleep kills another. Such was the case of Bernard Schedmaizig, who suddenly waking at midnight thought he saw a frightful phantom, which giving no answer to his challenge twice repeated, and seeming to advance upon him, he attacked with a hatchet that lay beside him. It was found that he had murdered his wife. Ray also relates the case of two men, who being out at night in a place infested with robbers, engaged that one should watch while the other slept; but the former falling asleep, and dreaming of being pursued, shot his friend through the heart. Again, there is the case of the pedlar, who being rudely roused from sleep by a passer-by, ran him through the body with the blade of a sword-stick; and was found guilty.* If these cases are rightly reported, it is difficult to understand how the homicidal act should be deemed criminal.

* These cases are quoted by Dr. Forbes Winslow in his 'Plea of Insanity in Criminal Cases,' the first from Dr. Pagan, the last from the 'British and Foreign Medical Review.'

Somnambulism.—This is a form of dreaming in which the senses and voluntary muscles have full play; the one exercised with extraordinary acuteness on the subject-matter of the dream, the other obeying the mandates of the sleeper's will with unwonted precision. The mind during the dream is so concentrated upon one object, that the reason or fancy will accomplish tasks to which it was unequal during the waking hours; and it is this concentration which probably accounts for that extraordinary acuteness of the senses, that precision of movement, and that total absence of fear which marks such acts as walking on the edge of a precipice, swimming a rapid stream, or riding at full gallop. Some sleep-walkers, at each recurrence of the fit, with the precision of their waking hours, perform some routine duty.

In some cases, so complete is the mind's abstraction, that the loudest noises are unheeded; in others, those things are only attended to which harmonize with the existing train of thought. There is either complete unconsciousness of what has occurred, or such remembrance of it as occurs in an ordinary dream. In some cases, that which has transpired in one fit only, is distinctly remembered in subsequent ones, but quite forgotten in the intervals.

The analogy already pointed out between dreaming and insanity may be extended so as to embrace some cases, at least, of somnambulism; for in some madmen, as in some somnambulists, there is a remarkable increase of talent, and there may be a complete change of character; so that it would be safe to state, that there is an intellectual and moral somnambulism, as there is an intellectual and moral insanity. The following cases support this view. A Carthusian monk, remarkable for simplicity, candour, and probity, walked almost every night in his sleep, a thief, and a plunderer of the dead. A pious clergyman, in his fits of somnambulism, would steal and secrete whatever he could lay his hands upon, and he even plundered his own church. In the case of a suicidal somnambulist, the fits occurred every night, and watchers were required, as if for a patient in an acute disease. He always tried to escape; and one night having succeeded, he was found hanging by the feet, from the limb of a high tree.* Homicidal somnambulism is illustrated by the following case. A monk late one evening entered the room of the prior of the convent, his eyes open but fixed, his features contracted into a frown, and with a knife in his hand. He walked straight up to the bed, as if to ascertain if the prior were there, and then gave three stabs, which penetrated the bed-clothes and a mat, that

* 'A Treatise on the Medical Jurisprudence of Insanity.' By J. Ray, M.D.

served the purpose of a mattress. He then returned with his features relaxed, and an air of satisfaction on his countenance. The next day, on being questioned, he confessed, that having dreamed that his mother had been murdered by the prior, and that her spirit had appeared to him and cried for vengeance, he was transported with fury at the sight, and ran directly to stab her assassin. Shortly after he awoke, covered with perspiration, and rejoiced to find that it was only a dream.*

Legal Relations of Somnambulism.—A question has been raised as to the responsibility of the somnambulist for acts committed during the fit, and an attempt has been made to show that, as that which is done in the fit is often only the accomplishment of a project formed while he was awake, he ought to be held responsible. This is a perfectly gratuitous assumption, and one that cannot be seriously entertained till some fact shall have been advanced in its support. If such a question of responsibility should arise it ought to be shown that the sleep-walking was not feigned, and that the accused was subject to it.

For some interesting cases of ecstasis, or cataleptic somnambulism, which is nearly allied to hysteria, and almost invariably occurs in females, the reader is referred to Dr. Abercrombie's work on the Intellectual Powers.

II. DELIRIUM, DELIRIUM TREMENS, AND DRUNKENNESS.

Delirium.—This occurs in most severe febrile and inflammatory diseases, and especially in those which attack the internal viscera. It is a common sequence of severe accidents, and surgical operations; and it often ushers in the fatal termination of chronic disorders.

The delirium of fever is generally preceded by pain and throbbing in the head, heat of the scalp, and flushing of the face; but it sometimes makes its attack suddenly, without previous warning. In the first class of cases it is often preceded by dreaming. The patient talks in his sleep, and wakes up confused and forgetful; but when fully roused, is collected, and so remains till the next slumber. By degrees this disturbed sleep passes into waking delirium. The patient lies on his back, dull and listless, with eyes half open, muttering to himself, unconscious of persons or things around him, and when roused scarcely recognising them. As the disorder increases and the strength fails, the voice becomes more indistinct, the fingers are constantly picking at the bed-

* Quoted from an anonymous work by Georget, 'Des Maladies Mentales,' p. 127.

clothes, the evacuations are passed unconsciously, and the patient can no longer be roused to an effort of attention.

If delirium occurs at an earlier stage of the disease, or before the strength has been much impaired, the symptoms are somewhat modified. The eyes are bloodshot, and intently fixed as if on some object really present. The patient talks loudly and earnestly, tosses restlessly about, makes repeated attempts to leave his bed, perhaps escapes from the attendants, displays great strength and activity, and may even commit acts of fatal violence.

In some attacks of delirium, the memory of things long past becomes wonderfully active, and languages in complete disuse are recollected and spoken with perfect fluency.

In fatal cases, delirium usually passes into coma, but occasionally it disappears some hours or days before death, leaving the patient in full possession of his faculties.

Delirium is an almost constant symptom of poisoning by belladonna, hyoscyamus, and stramonium; a frequent result of poisoning by other narcotico-acrids; an occasional one in poisoning by the pure narcotics; and it may even occur from the operation of irritant poisons.

Delirium bears a close resemblance to the form of unsound mind known as incoherence. The two disorders are readily distinguished by their history. Delirium, when not caused by poison, is a symptom of some well-marked disease, generally febrile or inflammatory, while incoherence is rarely accompanied by bodily disorder, till it has lasted long enough to become associated with paralysis.

Legal Relations of Delirium.—Civil acts performed during an access of delirium are necessarily void, and criminal acts entail no responsibility. In determining the validity of wills made by patients labouring under diseases attended with delirium, the law has regard less to the proved existence of a lucid interval, than to the character of the will itself. If in keeping with the testator's known character, and in harmony with intentions expressed or instructions given when sound in mind and body; if the several parts are consistent with each other; and if no improper influence was brought to bear upon him; the will would be declared valid, even though the medical evidence threw doubts on his capacity. On the other hand, in the absence of these conditions, the will would generally be declared invalid, in spite of the strongest evidence of his capacity.

It is important to distinguish delirium, with intervals of perfect consciousness, from the calmness of demeanour sometimes assumed by patients labouring under strange delusions, the result

of unsoundness of mind showing itself in the first stage of convalescence from fever or other acute disease; or as part of delirium tremens brought on by drinking. Here, too, the history of the case, as well as the state of the patient, will have to be carefully considered.

Delirium Tremens.—The delirium of drunkards is easily recognised by the peculiar form which the mental unsoundness assumes, and by the equally characteristic bodily symptoms, aided by the previous history; and, in most cases, by the prompt cure effected by the usual remedies—alcoholic stimulants and opiates.

The patient is restless, sleepless, timid, suspicious, and cunning. He is subject to illusions of the senses, and fancies himself surrounded by hideous and loathsome objects, such as toads, serpents, and scorpions, and that he is persecuted by strange sounds and threatening voices; or he thinks that thieves or evil spirits are breaking into the house. When under treatment he is suspicious of the attendants, is constantly trying to escape; and, if not properly watched, may do violence to himself or others. Some patients display a painful eagerness to go somewhere, or do something on which their minds are bent. The bodily symptoms consist of the tremor from which the disease derives its name, with a pale, cold, clammy skin, a moist, white, tremulous tongue, and a small weak pulse. The history of the case is that of a course of intemperance terminated by a short supply of liquor, or by some exhausting disease or surgical injury. Sometimes it follows a single debauch.

In the milder forms of the affection, the patient goes about as usual, answers questions collectedly, and converses rationally; but when left to himself, he is as one in a waking dream, speaking of things calculated strongly to excite the feelings and passions with a manner perfectly free from excitement.

Some cases of delirium tremens, however, are accompanied by strong excitement, so as to present the closest resemblance to mania, the patient being impelled to acts of violence against himself and others by the most unfounded delusions. Such cases are most commonly brought about by a few days or weeks of continuous hard drinking; or as the result of a single debauch, in men who have had previous attacks of mania, or of inflammation of the brain, or who have suffered from severe falls or blows on the head.

Prolonged abstinence, too close attention to study or business, and solitary confinement, sometimes bring on a state closely allied to delirium tremens, and characterized like it by illusions of sight and hearing.

Legal Relations of Delirium Tremens.—As delirium tremens

is a recognised disease, with mental unsoundness as one of its symptoms, the patient cannot be held responsible for his acts. Accordingly, though drunkenness has no effect on civil or criminal acts, delirium tremens is allowed to have the same effect as insanity itself.

Drunkenness.—The excitement which, in persons of sound mind, attends the indulgence in alcoholic liquors, is converted, in persons of unsound mind, into maniacal incoherence, not distinguishable from mania due to other causes, except by the history of the case and the evidence of the sense of smell. A craving after spirituous liquors is one of the recognised forms of unsoundness of mind (dipsomania); while in others it is merely a leading symptom of a more general disorder. In some cases the craving after alcoholic liquors is intermittent, showing itself only at intervals.

Legal Relations of Drunkenness.—This has no legal effect on any offence to which it leads. It neither increases nor mitigates the penalties that attach to it. It has even been deemed an aggravation. A drunkard's acts are therefore valid, unless it can be shown that the drunkenness was procured by another person with a view to an unfair advantage.

III. OF THE SEVERAL FORMS OF UNSOUND MIND.

On referring to the table at p. 162, it will be seen that these resolve themselves into three leading classes—*Amentia, Dementia,* and *Mania.*

AMENTIA.

This form comprises the two species, *idiocy* and *imbecility,* as well as the cases of defect traceable to local causes and known as *cretinism.*

Idiocy.—The best legal and medical writers agree in defining idiocy as a congenital malady, and the idiot as one "who from his nativity by a perpetual infirmity is *non compos mentis.*" But some writers of both professions have used the term with less precision, evidently confounding the idiot with the victim of dementia, or even of mania. The time for such confusion of terms is now past, and there is a clear understanding that idiocy is a congenital absence or serious defect of all the mental faculties; but a state admitting of degrees, and, like other forms of unsoundness, not allowing of strict definition.

Idiocy, in its lowest form, combines the extreme of bodily deformity with an existence purely vegetative. Such idiots seem

devoid even of sensation, and would perish if not closely attended to. In a somewhat higher form there are sensations of heat and cold, of hunger and thirst, and just intelligence enough to indicate the commonest wants by signs. A still higher class consists of those idiots who have sensation and consciousness, recognise familiar persons and objects, are susceptible of attachment, can move from place to place, are able to make known their wants by gestures and sounds, or even by words imperfectly articulated, can be made to acquire habits of decency, can learn to hum or sing, or even to perform the simpler operations of arithmetic, and are susceptible of a certain limited improvement of their bodily and mental condition under careful, assiduous, and skilful teachers.

As a rule, idiots are deformed in body as well as stunted in intellect. They have small and misshapen heads, and features ill-formed and distorted—squinting eyes, large gaping mouths with thick lips, irregular teeth, and sallow and unhealthy complexions. The limbs and trunk are also imperfectly developed, and their gait is awkward and unsteady. Some of their senses are wanting, and others very imperfect.

Fig. 21.

Fig. 21 (one of the graphic illustrations of the late Sir Alexander Morison*) shows the head of an idiot of this type, 28 years old, four feet and a half high, with flattened forehead, thick lips, and large gaping, slobbering mouth, awkward and unsteady gait, his favourite posture leaning against a door, and beating it gently with his head. His sense of touch is very obtuse; his utterance is limited to the monosyllable *tee, tee;* his temper is good, and he often laughs discordantly. He can feed, but cannot dress or undress, himself; is inattentive to the calls of nature; exhibits no affection; shows no shame; is not moved by music, and is said to be inclined to onanism.

The female idiot, fig. 22, is 18 years of age; has a small and flattened head, is short of stature, but not deformed; has a vacant

* The illustrations which follow are from the same source.

expression, and silly laugh; repeats the monosyllable *um*, *um*, and has been brought to repeat, parrot-like, the words *good day*, *good night*. She is fond of sweets, and pleased with finery. She puts a watch into her mouth. She feeds herself, but cannot dress or undress, and does not attend to the calls of nature.

Fig. 22.

The child whose portrait is given in fig. 23 belongs to the smaller class of idiots free from cranial and facial deformity. His age is six. He has been an idiot from birth, but appears to have grown worse after attacks of measles and whooping-cough in his third year. His senses are perfect; he can say a few words, such as *mother*, and *poor boy*; has affection for his parents, takes an interest in watching his father at work, and exhibits slight power of imitation: feeds himself, but will eat fish and flesh raw; is attentive to the calls of nature; is very restless, and keeps up a continual whine.

Fig. 23.

Idiots who reach the age of puberty often display the sexual passion by offensive gestures and disgusting habits, are subject to violent outbursts of passion, and sometimes commit acts of atrocious cruelty.

The Legal Relations of Idiocy, in the sense here assigned to the term, are obvious. It implies complete civil disability, and irresponsibility.

Imbecility.—This term is here used to designate a mental defect manifesting itself in infancy, as distinguished from that which is congenital.

In strictness of language, perhaps idiocy and imbecility would be equally characterized as congenital defects, of which the more marked (idiocy) makes itself soonest known, while imbecility is not recognised till the faculties have been tested by education, and found wanting. It is also obvious that no sharp line of distinction can be drawn between the idiot and the imbecile, for the fainter shades of imbecility pass into the lighter tints of idiocy. But the possession by the imbecile of the faculty of speech, as distinguished from the parrot-like utterance of the few words which can be taught to the idiot, is the best line of demarcation which the case allows of.

Most imbeciles show intellectual as well as moral deficiency. They have a limited power of acquiring or retaining knowledge; cannot understand or appreciate the customs of society or laws human and divine; cannot bring their emotions and passions under the control which men of sound mind exercise over them. But there is a small exceptional class which exhibits intellectual deficiency without seriously offending against morality, and a larger one, which combines the highest intellectual endowments with utter incapacity in the conduct of life. There is, therefore, an intellectual, a moral, and a general imbecility, as there is an intellectual, moral, and general mania.

Fig. 24.

The first of the annexed illustrations (fig. 24) represents an imbecile thirty years of age, and four feet nine inches in height, who is described as having a very small head, and an expression of silliness in his countenance; his eye, however, is rather lively, and he possesses more intelligence than we should expect from his

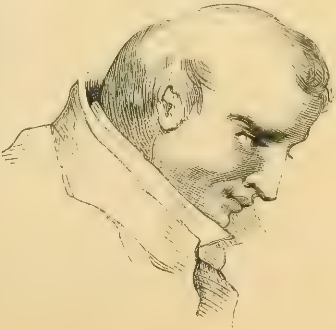
appearance; he can talk rationally upon common subjects, and makes himself useful. He has worked in servile offices.

The subject of the illustration in fig. 25, like the idiot child in fig. 23, is well-formed in face and limb. He is eighteen years of age, and four feet nine inches high. He has been a baker and a waiter at an inn. His features are good and their expression agreeable, but somewhat vacant. He speaks plainly, answers questions rationally, has been taught to read and write, is fond of music, for which he shows some talent, and he has a good voice, a correct ear, and sings very well. He says that he will always be a good boy, be polite and bow to gentlemen on whom he may wait, and will work like anything if work be given him. He feeds, dresses, and undresses himself, and is attentive to the calls of nature. He is subject to epileptic fits, and is disposed to quarrel, to tell lies, and to indulge in a solitary vice.

Fig. 25.

Fig. 26 is a portrait of a man of forty, of weak intellect from birth, but capable of such education as fitted him for the post of a copying clerk. He fell into bad company, committed theft, and was tried, and acquitted on the ground of insanity. In general he is quiet and inoffensive, taciturn, but answering simple questions rationally. He is subject to frequent at-

Fig. 26.



tacks of excitement, which last several days, and are preceded by shuffling of the feet. In these attacks, he talks incoherently, is restless, and will strike and kick those about him. When he was about thirty years old, he shut the door of his room, placed a long form close to the fire, laid himself on the form, and his head on the fire. In this position he was found insensible. He was removed to an open window, had a copious bleeding from the nose, and soon came to his senses. His head was burnt to the bone.

The form of imbecility which is most common, and most important in a medico-legal point of view, is that which affects the intellect, the morals, and the prudential conduct of life. Persons who exhibit this threefold deficiency profit by education, so as to form and express simple ideas, to read, write, and count, and to become musicians, draughtsmen, or mechanics. They may even attain proficiency in some one branch of knowledge, or some one accomplishment. But they do not profit by the opportunities afforded them in the same degree as their neighbours, and they present great varieties of character. Some are fickle and changeable, and incapable of fixing their attention; others are methodical and persevering. Some are found fit only for the coarsest and rudest labours, while others are equal, with the assistance and guidance of others, to the conduct of business and management of property. Others know the value of money, and can give information on matters with which they are conversant, but are unequal to emergencies, and unable to sustain close conversation or argument. They are thoughtless, improvident, uneasy, and restless, and generally incapable of strong and steady attachment. Imbeciles are very common among the lower orders of society. They are found following occupations requiring little sense or skill, and their neighbours look upon them as weak and singular persons, and tease and torment them accordingly; or they become lazy, drunken, and dissipated, and addicted to begging and petty larceny. Some, under slight temptation, and very inadequate motives, break out into fits of ungovernable passion, and commit acts of theft, arson, rape, or murder. "They steal adroitly, and hence are considered as very intelligent: they recommence their offences the moment they are released from confinement, and thus are believed to be obstinately perverse." "They have no idea, or a very imperfect one, of society, laws, morality, courts, and trials; and though they may have the idea of property, they have no conception of the consequences of theft. They may have been taught to refrain from injuring others, but they are ignorant of what would be done to them if guilty of incendiarism or murder."

"Their conduct is actuated solely by the fear of punishment, when capable of experiencing that sentiment, and by their own desires." Gorget, from whose work, 'Sur la Folie,' these passages are quoted, says that "these beings of limited capacity furnish to the courts of justice, to prisons and scaffolds, more subjects than is generally supposed"—a statement the truth of which we are able to confirm by our own experience.

But imbecility, as already pointed out, is not always of this mixed character, displaying itself at the same time in the intellect, morals, and conduct. It is sometimes partial, affecting only or chiefly either the intellectual or the moral character. There may be, on the one hand, an inability to acquire and apply knowledge in persons who have a due sense of right, act with integrity, and perform every social duty; and, on the other, an unusual power of acquiring knowledge, with judgment, fancy, and refined taste, but combined with feebleness of purpose, want of self-control, inaptitude for business, disregard of duty, and want of common honesty. Such persons are known in society as weak, soft, easy, good-natured, well-meaning, good sort of people, and if possessed of brilliant talents, as having every sense but common sense. They are too easy to be just; too thoughtless to be honest. They have an instinctive horror of business, an aversion to their regular occupations, and a distaste for everything that wears the shape of a duty. They are utterly ignorant of the value of money, and the last use they make of it is to pay their debts. Each man among them has his own favourite form of extravagance, and his own mode of ruining himself. One calls an architect to his assistance; another an upholsterer; a third collects useful things which he never uses, or displays a curious taste in worthless trifles; or (worse still) becomes the incorrigible patron of mendicants and mendicant-thieves. These people are always forming acquaintances with unworthy persons, who find it worth their while to know and to flatter them. With all their easiness of disposition they have much warmth of temper and strength of passion. They are bad children, husbands, and fathers, because in these relations they have duties to perform. Throughout life they are weak, wavering, fickle, and self-willed as children; the source of constant anxiety and misery to their families; the prey of designing knaves; the expected inmates of gaols, workhouses, and lunatic asylums.

These moral imbeciles remain at large, because the intellect being unaffected, they have no distinct delusions, and as weakness of intellect is a necessary ingredient in the legal idea of imbecility, the attempt to prove such persons of unsound mind, in a court of law, necessarily fails. That absence of moral sense, and

corresponding want of self-control, which is the essence of their mental malady, is to be proved only by the history of their daily life, which is often hard to obtain, and very generally studiously withheld.

Imbeciles are sometimes as much under the dominion of childish fancies as maniacs are of delusions. Some years since a commission of lunacy was granted in the case of a young gentleman, aged 20, who was the slave of a childish fancy for windmills, with an aversion equally strong to watermills. Having been placed under control in a place where there were no windmills, he cut the calves of a child's legs through to the bone, and stated that he should have taken away its life, that he might be tried for his act, and removed from a place where there were no windmills. He had always been violent when thwarted in his fancy, had threatened his keeper and members of his family, and had more than once made preparations for committing murder.

Legal Relations of Imbecility.—In respect to this form of mental unsoundness, two kinds of questions may arise—questions of *competency*, and questions of *responsibility*.

The *competency* of imbeciles to form contracts, and their validity when formed, has often engaged the attention of our courts of law. Persons of weak mind have been brought by improper influence to ally themselves in marriage, and the validity of such marriages has been successfully disputed, as in the case of Portsmouth *v.* Portsmouth, in which, as in other instances that might be cited, the proof of imbecility was rightly drawn not from a few isolated facts, but from an investigation of the whole life, conduct, and character of the party.

The competency of imbeciles to manage their affairs is often called in question. As the conduct of life is partly dependent on a knowledge of the use and value of money, partly on judgment and discretion, inquiries of this class may assume a very simple, or a very complicated shape.

In rare instances men have been pronounced incapable of managing their affairs, on the ground not so much of general weakness of intellect, as of defective knowledge of numbers and the value of money. Two such cases are related by Dr. Abercrombie, in one of which there was a "total inability to perform the most simple process of arithmetic," and in the other "a total want of the power of tracing relations both as to time and numbers." In the face of evidence showing that they had made much progress in their education, both were pronounced incapable of managing their affairs.

An imbecile in whose case we were called to give evidence,

did not know how many pence there were in a sixpence or a shilling, or how many shillings in a sovereign; could not perform the easiest operation of arithmetic; was ignorant of the date, month, and year; did not know the name of the reigning monarch; could not recognise persons with whom he had conversed only four days previously. His attention was roused with the utmost difficulty, and could not be fixed to any one subject. His look was vacant, his dress peculiar, his gait awkward, his motions grotesque, his speech slow and hesitating. He used the same words and expressions again and again, repeated imperfectly the tasks and prayers of his childhood, and imitated the contortions of persons, like himself, subject to fits. Such a case could present no difficulty either to witness or jury.

Questions of more difficulty arise in respect of persons who though they display many marks of imbecility, in childish ways, eccentric habits, violent passions, and cruel dispositions, are yet able to perform the simple operations of arithmetic, know the value of money, and can comprehend such statements and suggestions with respect to their affairs as are submitted to them. In some of these cases, a successful appeal has been made to the efficient manner in which the party has actually conducted his own affairs.

The proof of imbecility, combined with undue influence, has, in many instances, been held to invalidate a will; but, in the absence of such influence, all that is required to establish the wills of people of weak understanding is, that they should have been capable of comprehending their nature and effect.

The question of *responsibility* for such acts as arson and murder, can only be answered by weighing well all the circumstances of the act, the motives by which it was instigated, and the whole life and character of the accused. This subject will be considered when all the forms of unsound mind have been passed in review.

Several interesting and instructive cases of imbeciles concerning whom the two questions of competency and responsibility have been raised, are given in detail, and made the subject of judicious commentary in Ray's 'Treatise on the Medical Jurisprudence of Insanity.'

Cretinism.—In many parts of the continent of Europe, especially in valleys lying among hills, but occasionally in unhealthy rural and urban districts in all parts of the world, a disease prevails which combines the extreme of bodily deformity and degeneracy with deficiency of intellect. In Switzerland and Savoy persons so afflicted are called *cretins*, and in France *cagots*. The morbid

feature by which they are chiefly distinguished is the enlargement of the throat, known as *goitre* or *bronchocele;* but to this several bodily defects and deformities are superadded. The stature is dwarfed, the belly large, the legs small, the head conical, the arch of the palate high and narrow, the teeth irregular, the mouth large, the lips thick, the complexion sallow, the voice harsh and shrill, the speech thick and indistinct, the eyes squinting, the gait feeble and unsteady, the sexual power weak, or wanting.

The best authorities represent this physical degeneracy, with the coexisting mental deficiency, as commonly dating from a period subsequent to birth. About the fifth or sixth month, the bodily development seems to be checked. The child looks unhealthy and seems weak; the head is large, and its bones widely separated; the belly swells and the limbs shrink; teething goes on very slowly, and the child cannot stand or speak till its fifth or sixth year. Some cases are complicated with spinal distortion, some with hydrocephalus. In rare instances the physical and mental deficiency dates from birth.

The victims of this singular affection are usually divided into three classes—cretins, semi-cretins, and the cretinous, or cretins of the third degree. The first class answer to the description of idiocy already given, with the addition of the peculiar deformity of the throat. Their life is automatic; they have no intelligence; their senses are dull, or wholly wanting; they are unable to speak; their time is spent in basking in the sun or sitting by the fire; and only the most urgent calls of nature rouse their attention. They do not possess the power of reproduction.

The next class, or semi-cretins, show a higher intelligence. They can be taught to read and to repeat prayers, but without understanding what they learn; they have no idea of numbers; they note what passes around them, and use language to express their wants; they remember common events, understand what is said to them, and speak intelligibly on common subjects.

Cretins of the third degree show glimpses of a higher nature, and are capable of attaining a certain degree of proficiency in mechanical employments and contrivances, in drawing, painting, and music; but arithmetic is a very rare acquirement. They are said to be acutely alive to their own interest, extremely litigious, unable to manage their affairs, but obstinate and unwilling to be advised.

Cretins of the second and third degrees, if removed from their birth-place early in life, and put under judicious superintendence, may be greatly improved both in body and mind, and become useful members of society.

DEMENTIA.

This form of mental unsoundness is readily distinguished from the two forms of *amentia* just described. In idiocy the deficiency is congenital; in imbecility it shows itself in early life; in dementia, on the contrary, it supervenes slowly or suddenly in a mind already fully developed, and in childhood, manhood, or old age. On the other hand, it differs from mania, inasmuch as it consists in exhaustion and torpor of the faculties, not in violent and sustained excitement.

The mental state in dementia is best described by the word incoherence. There is also a form of mania equally well described by the same word; but the incoherence of dementia is marked by languor, that of mania by excitement. It must, however, be understood that patients suffering from dementia are liable to maniacal paroxysms, and maniacs to remissions of comparatively tranquil incoherence.

Dementia is divided into *acute*, or *primary*, and *chronic*, or *secondary*, of which the first form is rare, and consists in a condition of profound melancholy or stupor; the second very common, and characterized by incoherence. There is also a Senile Dementia, and a form of dementia associated with General Paralysis.

There are also degrees or stages of dementia, which Prichard indicated by the words forgetfulness, irrationality, incomprehension, and inappetency. A patient suffering from dementia, as he passed from bad to worse, would first exhibit want of memory, then loss of reasoning power, then inability to comprehend, and, lastly, an abolition of the common instincts and of volition.

1. *Acute Dementia.*—That form of *dementia* which arises from sudden mental shocks often presents a distinct and very peculiar feature.—The mind is, as it were, arrested and fixed for the remainder of life in sad abstraction on the one event which had occasioned it. In other instances, the shock destroys the power of the mind, and brings on a state similar to that of the imbecile or idiot.

During the earthquake panic of 1843, we saw a case of dementia in a lad twelve years of age, brought on by the alarming conversation of a knot of Irishmen in the dusk of the evening. The poor boy seemed deprived of all his faculties, was dull and listless, and answered every inquiry by a vacant smile. He had an occasional access of terror and excitement, but soon relapsed into stupor.

2. *Chronic Dementia.*—This form of dementia may generally be traced to some antecedent acting gradually on the mind, such

as prolonged grief or anxiety; to severe attacks of fever, mania, melancholia, apoplexy, paralysis, or repeated attacks of epilepsy. In all these cases it may depend on softening or other chronic disease of the brain, It may be inferred from two melancholy cases of recent occurrence that the inhalation of one poisonous vapour at least (mercuric methyl) has the power of inducing in healthy men a state of brain passing gradually into the most hopeless dementia.

3. *Senile Dementia*, or that which is incidental to aged persons, is a simple and well-marked form of the dementia which arises from causes acting slowly and gradually. The first symptom is loss of the memory of recent events, with dulness of perception and apprehension, and an inability to fix the attention, or follow any train of thought. The things heard five minutes since are forgotten, and the same question is repeated again and again. Hence, the transaction of business requiring sustained attention becomes impossible. The control of the will over the thoughts becoming more and more enfeebled, the reasoning powers suffer; for scarcely are the premisses laid down before they are forgotten, so that the act of comparison by which the conclusion is arrived at cannot be performed; and after pursuing the same topic of conversation through part of a sentence, some accidental suggestion turns the ideas aside. Persons so affected know their attendants and recognise their friends, but they seldom display signs of emotion on seeing them; and they can still employ themselves mechanically,—men in writing, and women in knitting and sewing. The next phase of the malady is one of complete incomprehension. Memory, reason, and the power of attention are entirely lost; but the muscular force remains intact, and displays itself in perpetual activity, in jumping or running to and fro, or walking round in a circle, or rocking backwards and forwards in a chair, dancing, singing, and shouting, or in talking or muttering incessantly. Many, however, sit silent and tranquil, or with a vacant unmeaning stare, for weeks, months, or even years. A few remain crouched in one uneasy posture, or they stand erect with the neck rigidly fixed at right angles to the body. Some display obstinate delusions. In the last stage of all, even the animal instincts are lost; there is neither sensation, memory, thought, nor reason, but bare physical existence; with occasionally, at distant intervals, a short resuscitation of some of the mental powers.

4. *General Paralysis* (*Paresis*).—The weakened state of the mind in this interesting form of dementia shows itself in most cases by delusions of unlimited power and boundless wealth; in all by progressive decay of bodily and mental power. Among the early

symptoms are neglect of duty, a restless and wandering disposition, the commission of petty thefts, indecent exposure of the person, acts of extravagance, and a sudden change of opinion and feeling, moral and religious. The disease is rare in women, common in men of education and position; and it generally shows itself in adults of middle age—from thirty to sixty. Its causes are intemperance, sexual excesses, the anxieties and undue mental labours of the active and stirring period of life, and hereditary taint. The mental defect is sometimes recognised before the paralysis, sometimes with it, and sometimes the spinal marrow is first affected, then the structure and functions of the brain. Its duration is usually stated at from a few months to three years. The paralytic symptoms show themselves first in the tongue, lips, and features. The articulation is hesitating and indistinct; the lips, tongue, and muscles of the face are tremulous and quivering; the pupils are often unequally dilated. Then the muscles of the limbs are affected. The patient trips, stumbles, and staggers, and can no longer perform such combined muscular movements as playing on musical instruments, writing, and sewing. These paralytic symptoms go on increasing, and, at length, the sphincters cease to act, and it is not uncommon for death to happen from suffocation in the act of swallowing food. Occasional fits of violence and of epilepsy occur to vary what would otherwise generally prove a gradual descent towards death, with increasing weakness and helplessness. At the last, sloughing bed-sores, and attacks of diarrhœa or pneumonia close the scene. One noteworthy and characteristic feature of the malady is the change in the expression of the countenance in an early stage. Through the relaxation of the muscles, the wrinkles of the face disappear, and the patient seems to have grown younger; but at a later stage, the face becomes curiously wanting in expression. But to the last the mental characteristics remain the same, and the last muttered words are about "gold, and carriages, and millions of money."*

The figures annexed (see next page) represent the early and advanced stage of General Paralysis in a gardener, æt. 38. The misconduct of a daughter had brought on a state of melancholy which lasted for a fortnight, at the end of which time he began to insist that he was the king, that he was in his palace which was made of gold, and that he had a million of money. His memory failed him, he did not know the month or year, his speech was slightly impaired, but his walk was tolerably firm. Fig. 27 was taken a month after the appearance of these symptoms, and

* L Meyer: quoted by Maudsley in his 'Physiology and Pathology of the Mind,' p. 364.

fig. 28 after the lapse of another month, when the disease had made much progress, as was shown by the increased embarrass-

Fig. 27.

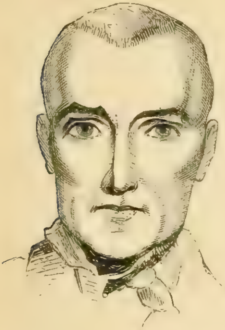


Fig. 28.

ment of his speech, the nearly utter loss of memory, his tottering gait (for he could scarcely walk at all), and, notwithstanding a very good appetite, his rapid emaciation.

Legal Relations of Dementia.—One of the questions frequently raised respecting this form of unsoundness relates to the validity of wills made or altered by persons alleged to be suffering from senile dementia. The inquiry is generally one of considerable difficulty; inasmuch as such persons vary greatly from day to day, and present themselves to different observers in different lights. Accordingly there is room for very conflicting testimony, and wide divergences of opinion, both among unskilled and skilled witnesses; and the legal decision ultimately turns much more on the character of the will itself and its consonancy, or otherwise, with the known intentions and views of the testator at an earlier period of his life, and with the natural feelings of persons of sound intellect, than on the medical or other evidence respecting his mental condition.

Dementia, as it occurs at earlier periods, is a common subject of the inquiry *de lunatico*. A demented person lapses into habits of ruinous extravagance, and the inquiry has for its object partly to ascertain whether he is able to manage his affairs, and if not, since what date the incapacity has existed. This inquiry, difficult in itself, is made more embarrassing by the strong rival interests which always grow up around persons of this class.

The existence of general paralysis, in any degree, would, of course, of itself form a strong presumption against the competency of the subject of it, implying, as a very general rule, exaggerated ideas of wealth, and inability to make a reasonable use of money.

The responsibility of the demented for acts which in the sane are crimes will be considered presently.

MANIA.

This term includes all those forms of unsoundness which are characterized by undue excitement. It differs therefore in a marked manner from those already described. There is no legal term in common use which properly characterizes this state; and one of its most important forms, moral insanity, is as yet unrecognised by the law. The only legal term employed in a sense analogous to that of mania is *lunacy*, which, as already remarked, is objectionable from being founded on a variable feature of the disease.

There are three forms of Mania (table, p. 162): *General, Intellectual,* and *Moral;* and each of the two latter has two subdivisions—*General* and *Partial.*

General Mania.—This form affects the intellect as well as the emotions and passions, and throws the whole mind into a state of mingled excitement and confusion. It is the counterpart of the incoherence of dementia, and the form which, in some cases, mania assumes from the very first. It would be correctly designated by the phrase "raging incoherence." There is another form liable to be confounded with this, on the one hand, and with monomania, on the other, but which, when carefully examined, is found to be a general unsoundness, with undue excitement of some predominant emotion or passion which takes the lead in the unsound, as it had previously done in the sound mind.

Mania, whatever form it assumes, unless it be the immediate consequence of injuries, moral shocks, intoxication, poisoning, or acute disease, is preceded by important bodily and mental changes, which take place gradually, occupying a variable period of time, from a few days, to 15 or 20 years, and known as the period of *incubation.*

When the period is short, the disease shows itself at the end of some hours or days of anxiety, uneasiness, and depression, with headache, sleeplessness, and excitement. The patient begins to babble, cry, and sing, becomes wild and agitated, and appears like a person in a state of intoxication. When the period of incubation is lengthened out, the disease generally commences with a consciousness on the part of the patient of

some disorder in his mental faculties, of odd notions, unusual inclinations, and changing affections. He is vexed at the change, and tries to conceal it; continues his occupations; and, like a man in the first stage of intoxication, makes great efforts to appear reasonable. Meanwhile his health gives way. His sleep is disturbed; he loses flesh and appetite; and suffers from indigestion and constipation. At the same time, a great change takes place in his tastes, habits, affections, and character, and in his aptitude for business. If he was gay, communicative, and social, he becomes sad, morose, and averse to society; tears and laughter succeed each other without apparent cause; if open and candid, he becomes suspicious and jealous; if moderate in his political and religious opinions, he passes to an extreme exaggeration in both; if affectionately attached to wife, children, and relations, he regards them with indifference or dislike; if he was orderly and economical, he becomes confused and prodigal; if correct in conversation, his language becomes violent and obscene; if chaste, or moderate in sexual indulgence, he becomes the victim of insatiable desires, and either seeks to associate with the other sex, or has recourse to disgraceful practices.

If this is a first attack, the nature of the change is misunderstood; questions are put to him which harass him and give him pain; or he is irritated by offensive insinuations, and frivolous accusations: and when, at length, he breaks out into furious mania, the attack is attributed to some cause wholly inadequate to produce it.

The period of incubation passed, and the disease fully established, the mental and physical phenomena undergo a change. The patient has faith in his delusions, and instead of concealing his thoughts, openly and strenuously avows them, except when tempted by powerful motives to a contrary course. When thwarted and opposed he uses the most violent, obscene, and insulting language. Nor does his violence always spend itself in words, for he tears his clothes and bedding to pieces, and inflicts bodily injury on himself and those about him. The physical derangement displays itself in a flushed face, a wild sparkling eye, pain, weight and giddiness in the head, ringing in the ears, restlessness and sleeplessness. The patient is also singularly insensible to cold and heat, and either abstains from food and drink during long intervals of time, or eats voraciously. His muscular power is inordinately developed, and he sustains for a long time, without sleep, a succession of efforts which would soon utterly exhaust a healthy person. The habits of the patient are often most disgusting and offensive.

The appearance of the maniac during the paroxysm, and that which he wears in comparatively tranquil and lucid intervals is well shown in the annexed figures, of which fig. 29 shows

Fig. 29.

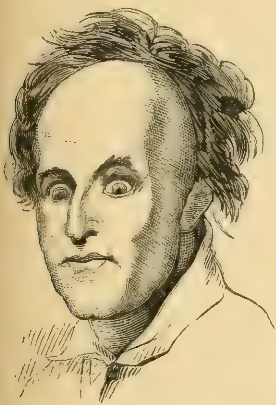
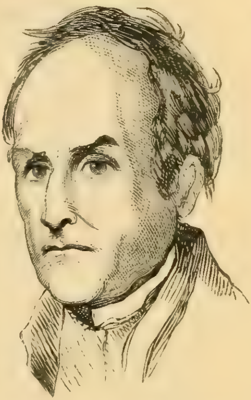


Fig. 30.



an epileptic maniac, æt. 60, in a paroxysm, and fig. 30 the same person calm and collected, and conducting himself with propriety.

General Intellectual Mania.—The opinion is gaining ground that mania is in all cases primarily an emotional disease, and that the affection of the intellect is secondary. But there is certainly one class of cases in which the disease appears to be almost limited to the senses which are the sport of strange illusions, or to the intellectual faculties, properly so called. Of the first class we have at least three good examples in the estimable gentleman of Argos, immortalized by Horace,

> "Qui se credebat miros audire tragædos,
> In vacuo lætus sessor plausorque theatro;"

in another at Abydos mentioned by Aristotle, and in the patient of "exalted rank" whom Sir Henry Halford saw in his fancied theatre, and heard "call upon Mr. Garrick to exert himself in the performance of Hamlet." In these cases it is believed that these mixed illusions of sight and hearing, looked upon as real, constituted the whole of the unsoundness. Of the second class a few examples might also be found, as in a gentleman who thought

himself secretary to the moon, but does not seem to have carried his unsoundness into sublunary affairs.

But there is certainly a very distinct and well-marked class of cases wrongly regarded as intellectual, but really dependent on the excitement of some strong emotion or passion, such as pride, vanity, or ambition. Thus Dr. Reid tells us of a vain young medical student, who, in the expectation of realizing a fortune by attaining academical honours, entered himself at Cambridge, and so injured his health by fruitless application to study, as at length to fall into a state of decided derangement, alleging that he was the Farnese Hercules; that he had written Dr. Clarke's Travels in Russia; that he had composed the Æneid of Virgil; had painted one of the masterpieces of Raffaelle; and that he knew everything.

Dr. Henry Johnson, in his work on the arrangement and nomenclature of Mental Disorders, also gives the highly characteristic letter of an ambitious patient who claimed the somewhat incongruous titles of champion and king of England, and heir presumptive to the crown, at the same time that he monopolized all the principal offices of state.

A highly instructive autobiography of a gentleman who had recovered from an attack of mania, shows how general was the disturbance of the whole intellectual and moral being, though the predominant emotion was of a religious character, and it would have been quite possible to describe the case as one of religious monomania.

General intellectual mania consists, therefore, in many cases, in a violent disturbance of all the intellectual faculties brought about by the over-excitement of some one leading emotion or passion.

Partial Intellectual Mania.—This was called melancholia, from the mistaken notion that such partial affections of the intellect are always of a gloomy character. Esquirol, however, showed that the ideas of such persons are not always gloomy, but, on the contrary, oftentimes extremely gay and pleasant; and he substituted the term monomania now generally received.

The simplest form of this disorder is that in which the patient takes up some one notion opposed to common sense, and universal experience. He is secretary to the moon, the Crystal Palace, a grain of wheat, a goose-pie, a pitcher of oil, a wolf, a dog, or a cat.

In many cases, this single delusive idea relates to, or is occasioned by, some sensation or disease, which the monomaniac, like the dreamer, associates with imaginary accompaniments, and in-

terprets by the aid of his delusion. Thus, Esquirol tells us of a woman having hydatids in the womb, who insisted that she was pregnant with the devil: of another, who having adhesions of the intestines after chronic peritonitis, imagined that she had a regiment of soldiers concealed in her belly, struggling and fighting; and of a third, who, suffering in the same way, believed that the apostles and evangelists had taken up their abode in her bowels, and were occasionally visited by the pope and the patriarchs of the Old Testament.

But such delusions as these, though originally founded on real sensations, may continue after the sensations themselves have passed away, as is proved by the cures that have been wrought by a laudable species of deception. Thus, a patient, thinking himself cured of a serpent in his bowels by a pretended surgical operation, suddenly took up the idea, that the creature had left its ova behind, ready to be hatched into a brood of young ones; but was reassured by the dexterous reply, that the snake was a male.

It must not be supposed that such cases of partial intellectual mania comprise all the cases designated as *monomania*. In most instances the affection of the mind doubtless goes beyond a single insane idea, and influences more or less extensively the thoughts and the conduct, being marked by other intellectual and moral inconsistencies.

Moral Mania.—It was Pinel who first directed our attention to this form of insanity, the disease having been previously considered as either exclusively, or chiefly, a malady of the reasoning faculties. He found, to his great surprise, that there were at the Bicêtre many maniacs "who betrayed no lesion whatever of the understanding, but were under the dominion of instinctive and abstract fury, as if the affective faculties alone had sustained injury." He called this form of mental disorder *manie sans délire.* The reality and great importance of this distinction between intellectual and moral mania are now universally recognised. Prichard, among others, has treated this subject with great ability, and established the important principle that moral generally precedes intellectual insanity. He defines moral mania as "a morbid perversion of the natural feelings, affections, inclinations, temper, habits, and moral dispositions, without any notable lesion of the intellect, or knowing and reasoning faculties, and particularly without any maniacal hallucination."

Moral mania, like the intellectual form, may be either *general* or *partial.*

General Moral Mania.—Prichard observes that there are

many persons living at large in society, who are reputed to be of a singular, wayward, and eccentric character. An attentive observer will often recognise something remarkable in their manners and habits, which may lead him to doubt their sanity; and often on inquiry his suspicions are strengthened by finding that an hereditary tendency to madness exists in the family, that several of the relations have laboured under other diseases of the brain, or that the individual himself has formerly had a decided attack of madness. His temper and disposition are found to have undergone a change; to be not what they were previous to a certain time; and the change may perhaps be traced to a period when he had some reverse of fortune, or lost some beloved relative, or sustained some severe constitutional shock, some febrile or inflammatory disorder affecting the brain, a slight attack of palsy, or a fit of epilepsy. In some cases, the alteration in temper and habits has been gradual and imperceptible, and seems to have consisted merely in an exaltation or increase of peculiarities which were always more or less natural and habitual. These persons are capable of reasoning or supporting an argument, upon any subject within their sphere of knowledge; and they often display great ingenuity in justifying and explaining their feelings and conduct, and in one sense, indeed, their intellectual faculties may be termed unsound; they think and act under the influence of the same strongly-excited feelings which render sane persons proverbially liable to error both in judgment and conduct.

Hoffbauer also recognises this form of unsoundness. "It is clear," he says, "that mania may exist uncomplicated with mental delusion; it is, in fact, only a kind of mental exaltation (*tollheit*), a state in which the reason has lost its empire over the passions and the actions by which they are manifested, to such a degree, that the individual can neither repress the former, nor abstain from the latter. It does not follow that he may not be in possession of his senses, and even of his usual intelligence, since, in order to resist the impulses of the passions, it is not sufficient that the reason should impart its counsels,—we must have the necessary power to obey them." Esquirol, also, fully recognised this form of unsoundness, and even went so far as to declare "moral alienation to be the proper characteristic of mental derangement," adding that though "there are madmen in whom it is difficult to find any trace of hallucination, there are none in whom the passions and moral affections are not perverted and destroyed."

Moral insanity is illustrated in the works of Prichard and Ray,

by a number of cases, which may be consulted with advantage. The most remarkable is that of Frederick William of Prussia, father of Frederick the Great, a drinking and smoking hypochondriac, and the strange, wayward, and cruel tyrant of his family and household. His religious austerities, his disgusting and brutal behaviour to his children, his unfounded hatred of his own son, and repeated attempts upon his life, his solitary attempt upon his own life, his course of steady and unswerving persecution of the innocent objects of his suspicion and dislike, without any delusion beyond that which might fairly be regarded as the offspring of his hate—present a striking picture of general moral mania.

Maudsley* gives us as "the extremest example of moral insanity" which he has seen, the case of an old man, æt. 69, who had been in one asylum or another for fifteen years. He had great intellectual power, could compose well, write tolerable poetry with much fluency, and was an excellent keeper of accounts. He had no delusion, but "morally he was utterly depraved." He would steal and hide whatever he could, and several times escaped from the asylum with marvellous ingenuity. He then pawned what he had stolen, begged, and lied with such plausibility that he deceived many people, until he got into the hands of the police, or was found in a wretched state in the worst company in the worst part of town. He had been several times in prison for stealing. In the asylum he was most troublesome, cunning, plausible, and treacherous; abusive, foul, and blasphemous in language; drew indecent pictures, and was guilty of most indecent acts. At long intervals, sometimes of two years, he fell into profound melancholy for two or three months, refused food, and was as plainly insane as any patient in the asylum. "In short, he had no moral sense whatever, while all the fault that could be found with his very acute intellect was, that it was entirely engaged in the service of his depravity."

Partial Moral Mania.—This consists in an exorbitant activity of some one passion or propensity, and its predominance or complete mastery over every other. The persons so affected are usually perfectly conscious of their condition, and either evince the utmost horror at the conduct to which their ruling passion would impel them, and with difficulty restrain themselves, or they give way, as if in desperation, to the impulse which urges them on.

There is not one of the strong impulses of our nature that may

* The 'Physiology and Pathology of the Mind,' p. 317.

not be thus placed, by morbid excitement, beyond the restraint of reason and conscience. The following are now generally recognised, and described under distinct names:—Kleptomania, Erotomania, Pyromania, Dipsomania, Suicidal Mania, Homicidal Mania. These are of special interest to the public and the legislature; but there are many other distinct varieties, some marked by extreme depression, and others by great excitement, which have been classed under the two heads of *Melancholia* and *Exaltation*, of which the first comprises the three species, hypochondriasis, nostalgia, and religious despair; and the second, excessive pride, vanity, or ambition.

Kleptomania, or *propensity to theft.*—This is very common in persons of both sexes, but especially women, placed by their wealth beyond the reach of vulgar temptation. It is also a common feature of imbecility and of mania, and has been known to accompany maniacal paroxysms. Prichard mentions the curious case of a madman who would never eat his food unless he had previously stolen it.

Erotomania, or *amorous madness.*—This disease, known as *Satyriasis* when it attacks men, and *Nymphomania* when it occurs in women, sometimes afflicts virtuous females, who view their excited passions with horror and remorse.

Pyromania, or *propensity to incendiarism.*—This propensity, in common with Kleptomania, is more common in women than in men, and is most frequent in young girls subject to menstrual suppression or disturbance. It is also very common in imbeciles of the other sex.

Dipsomania.—An excessive desire for drink is a well-recognised form of unsoundness. In some the desire is continuous; in others intermittent. In some it is part of a more general unsoundness; in others the true source of all the manifestations of unsoundness which the patient makes. He is perfectly rational when not under the influence of drink.

Suicidal Monomania.—Much difference of opinion has existed as to the real mental state of self-murderers. The fact of suicide having been generally practised and sanctioned by philosophers and lawgivers of past times, and of its still being in common use in nations which have attained in many respects a high civilization, such as China and Japan, has led some to the belief that it is not always the result of an insane impulse. The calm and deliberate manner in which the act is now often done, and the plausible reasons alleged in its defence, have been used as objections to the opinion that suicide is always an act of madness. Those who recognise a "folie raisonante" will not attach much importance to

this objection; but they will find a better reason for believing it to be, at least occasionally, independent of insanity in the fact, that in France two persons often combine for the purpose of self-destruction; such an union of purpose being extremely rare in the case of the insane. Our own experience of suicide leads us to believe that it is often the result of a sudden impulse on very slight provocation of persons not previously depressed in mind.

The argument drawn from national usage in ancient and modern times has not much weight; for who would hesitate to characterize an English widow who should burn herself on the death of her husband, as insane? and yet such self-sacrifice was till recently a laudable custom in India. Some savages, again, eat human flesh; but in a case of infanticide which occurred in France, the fact that the mother cooked a portion of her child, ate of it, and offered the dish to her husband, was justly regarded as a strong evidence of insanity.

A careful consideration of recorded cases of suicide cannot but lead to the conclusion, that very many are the result of insane impulse; and this conclusion is strengthened by the frequent attempts at self-destruction made by some inmates of lunatic asylums. The strange modes of death sometimes selected might also be urged as an argument in favour of the insane origin of suicide. It may be added, that some of our highest authorities, as Foderé and Esquirol, have strongly maintained the necessary dependence of suicide on insanity.

Homicidal Mania.—The most distinguished authorities, both at home and abroad, have recognised this form of mental unsoundness, as having an existence independent of delusion. The cases on record are now very numerous, and comprise instances of successful resistance to the impulse, of voluntary submission to restraint, and of failure.

Women seem to be more liable than men to this propensity, even when we set apart some cases of infanticide as special instances of it. Women suffering from grief, or anxiety, from habitual discharges, at the menstrual period, at the change of life, and soon after delivery, are thrown into a peculiar nervous state, known as *mimosis inquieta,* which is sometimes accompanied by a strong impulse to crime, with an overwhelming fear of giving way to it.

Puerperal Mania.—This is named after its cause, and not after any leading symptom. It attacks women who have been recently confined, generally at some period between the first suckling of the child, and the last show of the lochia, and is sometimes occasioned by the suppression of the secretions of the breast

or womb, but sometimes also in consequence of excessive lactation or profuse vaginal discharge, of great weakness however induced, or of want of sleep. The disease is rare before the third day, and most common between the fifth and fifteenth. The symptoms may be those of any of the leading forms of unsoundness; in many cases there is a strong homicidal tendency, and the child falls a victim to a sudden impulse, there being no assignable or imaginable motive, no concealment, and often no remorse.

Melancholia (Lypemania of Esquirol).—There are, as has just been stated, three principal forms of melancholia, all characterized by profound sadness. The first, *hypochondriasis*, consists in a melancholy and desponding view of the condition of the body and of the health, often, but not always, based upon uneasy bodily sensations and disorders of the organs of digestion: the second, *nostalgia*, consists in an intense longing for country and home: the third is *religious despair*. The extreme form of melancholia, associated with some terrible delusion, in which the patient is fixed in one position, like a statue, has been distinguished as *melancholia attonita*.

Exaltation.—This opposite of melancholia prevails in those who exult in the belief that they are possessed of great personal attraction, great power, great dignity, great inventive faculties, or great projects of benevolence.

Melancholia and exaltation sometimes alternate in the same patient with some approach to regularity, in which case we have the form of unsoundness to which some French authors have given the name of *folie circulaire*, or *folie à double forme*.

Cases also abound, both inside and outside of our asylums which would warrant the use of a larger vocabulary of terms—cases, for instance, in which a lying or begging propensity, or an insane pleasure in the act of giving or spending money, is quite as clearly marked as a thieving propensity in those designated as Kleptomaniacs. Nor is it possible to omit the remarkable recorded cases of *lycanthropy*, one of which (that of the soldier Bertrand) occurred within a few years of this time, in France. In this instance, the violation of the grave was an intermittent insane passion, which no sense of personal danger was allowed to disappoint.

The longings of pregnant women, carried to a strange excess in one who killed her husband, and pickled his body, to eat it (Maudsley); a persistent morbid desire to be hanged; and the killing of children by their fathers or mothers with the sincere purpose of sending them to heaven,—might also be properly described as distinct and well-defined forms of partial moral mania.

Of Mania with Lucid Intervals.—Mania, in a considerable number of cases, assumes a recurrent or intermittent form, the patient in the interval being in his right mind. The proportion which such cases bear to those of complete recovery has been variously stated at from one in six to one in ten. The interval is various. Esquirol has seen a quotidian, tertian, and quartan type, as well as the interval of a month, and it has recurred with the same season of the year. More frequently the attacks occur at uncertain intervals, and are of uncertain duration. This recurrent mania, with intervals of complete sanity, must not be confounded with those periods of comparative tranquillity which, like lulls in a storm, occur in most cases of mania. With regard to such intervals of comparative repose, Haslam remarks that, "as a constant observer of this disease for more than twenty-five years, he cannot affirm that the lunatics, with whom he had daily intercourse, have manifested alternations of insanity and reason. They may at intervals become more tranquil, and less disposed to obtrude their distempered fancies into notice. For a time their minds may be less active, and the succession of their thoughts consequently more deliberate; they may endeavour to effect some desirable purpose, and artfully conceal their real opinions; but they have not abandoned or renounced their distempered notions."

The law generally views civil acts done in *lucid intervals* as if they were performed by a person in a permanently sound state of mind; it admits the validity of wills made during such intervals, and has, on more than one occasion, admitted the reasonableness of the will as proof of a lucid interval. With regard to criminal acts, it makes a reasonable distinction; for it justly regards the condition of unsoundness as one readily reproduced by provocation or excitement. The legal relations of the other forms of mania will be fully considered in the following division.

IV. OF THE MORE IMPORTANT CHARACTERS OF THE UNSOUND MIND, AND OF ITS MEDICAL AND LEGAL TESTS.

A knowledge of the leading characteristics of mental unsoundness is of the first importance both to the lawyer and to the physician. Without it a mere description of its several forms would present but an imperfect view of the subject. It is proposed, therefore, to establish, by appeal to facts, the more remarkable phenomena of mental unsoundness, as preliminary to the discussion of the chief legal questions that arise out of that state; and to prescribe, for the guidance of the medical witness,

such rules as these phenomena shall be found to suggest for recognising it, and for distinguishing it from its counterfeit.

Of the Characters of Unsoundness of Mind arising from Defective Development or Diminished Activity.

The appearance of the idiot or imbecile is so peculiar as scarcely to require confirmation from an actual inquiry into his mental condition. Difficulty in rousing and fixing the attention; slowness of apprehension; forgetfulness of recent occurrences; ignorance of social relations; unconsciousness of familiar things, even of such as immediately concern a man's self, as his age, the place in which he lives, the mode in which he passes his time, the year, the month, the day of the month, and week; ignorance of those public persons and events which are the common topics of conversation with those who take an interest in the common affairs of life, as the name of the reigning monarch, of the prime minister, &c.; a scanty acquaintance with arithmetic and the value of money; an imperfect knowledge of right and wrong, and of the law relating to the most common and familiar crimes;—may be mentioned among the characters of unsoundness from defective development.

In ordinary and extreme cases of imbecility there can be no difficulty in deciding on the competency of the individual to take care of his affairs, to form contracts, to devise property; but where the imbecility exists in a less degree, the question is by no means of this simple nature, and there may be room for difference of opinion, especially when the subject of inquiry has actually been entrusted with the management of his affairs. In all such cases, a comparison of the existing with the former state of mind, supplies a simple and obvious test, which seems to have been strangely overlooked by medical men, till the interesting case of Mr. Edward Davies gave Dr. Gooch the opportunity of pointing it out, and insisting upon its importance. (See 'Quarterly Review,' 1830, and the first edition of this work.)

The tests of capacity usually recommended in cases of imbecility are obviously insufficient to determine whether or not a man is capable of managing his own property. The arithmetical test, on which authors have laid so much stress, is merely a test of knowledge, not of power. A man may be the best accountant in the world, but he may labour under a moral imbecility, and have so mean a sense of right, so childish a fancy, and so weak a will, that from infancy to age he may yield to every impulse, and gratify every whim without once counting the cost. A patient

of our own, with whom we had been intimate for years, owed pence as a child, and pounds as a boy, and added debt to debt with each year that passed over his head, till at length a severe disappointment brought on a distinct attack of mania, of which a benevolent but extravagant mission, violent outbursts of passion, and fierce hatreds, arrangements to spend a year's income in a week, and the unfounded expectation of an immense fortune on the morrow, were constituent parts. He carried with him to an asylum, delusions enough to furnish a dozen madmen, and died in the firm conviction that he was the Saviour of mankind. In this case, there was the cultivated and refined intellect of a man with more than the weakness of a child; but no test could have proved him incapable of managing himself and his affairs, save only the history of his life.

The criminal acts of persons of weak intellect are as strongly marked by folly as their daily words and actions. They have no surer characters, and we no better test. But in this case, as in that of maniacs, the law insists upon the test of a knowledge of right and wrong, which is as insufficient in criminal, as the arithmetical test in civil cases. It is a test of knowledge, not of power; and the knowledge of right, and the power to act aright, are as distinct as science and art.

Of the Characters of Unsoundness of Mind from Excessive Activity.

In tracing the more prominent characters of this division, or, in other words, of mania, the term will be used in its most extended sense as applied to those cases (and they are the great majority) in which the intellect, the affections, and the passions, are jointly implicated, whether there be one delusion or many, or merely some one excited emotion or passion, the source of a thousand changing fancies. This inquiry will prepare the way for an examination of the plea of insanity in criminal cases—a subject of great interest and importance.

1. *In mania, consciousness, memory, and reason may remain intact, even in the midst of the most violent paroxysms.*—The doctrine that mania is in all cases primarily an emotional disease is quite consistent with this proposition. It is quite conceivable that the emotions and passions may be subject to the most violent excitement, constant or intermittent, and yet the patient retain the most perfect consciousness of all the relations in which he stands towards others, the use of reason, and a perfect recollection of every occurrence in which he has borne a part. It is

true that in the actual paroxysm of maniacal excitement, there can be neither time nor place for acts of comparison or processes of reasoning, and that even conscience may lose all restraining power; but that memory does remain intact, even in the most violent maniacal outbursts, there is no room to doubt. We were consulted in the case of a lady who had been suffering from mania for a long term of years, and was subject to paroxysms of extreme violence; in one of which she had destroyed some valuable papers belonging to her husband; and yet after the lapse of twenty years, during an interval of tranquillity, she reverted to the occurrence, and expressed her regret at what had happened. We have found similar evidence of accurate recollection in the autobiographies and *vivâ-voce* histories of convalescents from mania.

Of the intact condition of the higher mental faculties in the maniac's more tranquil moments no medical evidence need be adduced. It will suffice to quote the words of Erskine, used at the trial of Hadfield for shooting at George III. in Drury Lane Theatre, in 1800. "In all the cases," he says, "which have filled Westminster Hall with the most complicated considerations, the lunatics, and other insane persons who have been the subjects of them, have not only had memory *in my sense of the expression*,—they have not only had the most perfect knowledge and recollection of all the relations they stood in towards others, and of the acts and circumstances of their lives, but have, in general, been remarkable for subtlety and acuteness. Defects in their reasoning have seldom been traceable,—the disease consisting in the delusive sources of thought,—all their deductions, within the scope of their malady, being founded on the *immoveable* assumption of matters as *realities*, either without any foundation whatever, or so distorted and disfigured by fancy, as to be nearly the same thing as their creation."

The madman, then, reasons like other men, with this difference, that his delusions being stronger than the imaginations of a sane man, and his passions more violent, reason is more readily made the advocate of the one and the slave of the other; and this is true of all the faculties of the mind, and even of the senses. His delusions are too strong even for them.

2. *The senses are deceived and confounded.*—The author of the autobiography referred to at p. 164, says: "My senses were all mocked at and deceived. In reading, my eyes saw words on the paper, which, when I looked again, were not. The forms of those around me, and their features, changed even as I looked on them." "I heard the voices of invisible agents, and notes so

divine, so pure, so holy, that they alone, perhaps, might recompense me for many sufferings. My sense of feeling was not the same; my smell, my taste, gone or confounded." The conversion of familiar sounds, such as the lowing of cattle, the falling of water, the grating of a chain, the noise of footsteps, into articulate speech, was not the least remarkable feature of this most interesting and instructive case. Illusions of sight and hearing, and illusive transformations of real sensations, are, it is well known, among the most general accompaniments of mania.

3. *The persons with whom the madman associates derive their characters from his delusion.*—In the eyes of the author of the autobiography the inmates of the asylum and his keepers were supernatural beings. There was a maniac there whom his spirits called the Lord Jehovah, supremely omnipotent, the Trinity in unity; and he took one of the keepers to be the Saviour of mankind. At other times these same persons assumed other shapes, and according to the state of his mind, were either fiends or angels.

4. *Real impressions on the organs of sense become, as in dreams, the materials of imaginary scenes.*—This curious phenomenon, also, is strikingly illustrated in the autobiography. When the cold air blows on the patient as he is trying to suffocate himself, in obedience to the spirits that speak within him, he conjures up the spirits of his sisters cooling him with their breath, and encouraging him to go through with his task. The familiar sensation of water trickling down the back is converted into the crystal tears of his father, whose venerable countenance he sees bending over him. His shaven head suggests the painful notion that he has received the tonsure of the Roman Catholic priesthood, a mark of the beast. The jets of gas in the fire become the utterance of his father's spirit, striving within him to save him, and obliged to return to hell-fire, to be purified from the contamination of his foul thoughts. The lowing of the cattle conveys to him articulate sounds and sentences, and the grating of the chair against the wall speaks to him in his father's voice.

5. *The strange antics of the madman are the effects of his delusion.*—The following passages from the autobiography fully establish this proposition: "I expected to be guided to prayer; but a spirit guided me, and placed me in a chair, in a constrained position, with my head turned to look at the clock, the hand of which I saw proceeding to the first quarter; I understood I was to leave the position when it came to the quarter." "Another delusion I laboured under was, that I should keep my head and heart together, and so serve the Lord, by throwing myself

head over heels over every stile or gate I came to; the condition here was, as before, on its being done in *precision and decision.*" A keeper, in struggling with a patient, throws him down and nearly strangles him. "When I saw his bloated and inflamed cheeks, and the eyes starting out of the sockets, I offered to do anything to rescue him. My spirits desired me to whirl myself round and round as fast as I could, which I did till I staggered against the wall, and nearly fell on the stone pavement." This last quotation suggests the corollary that

6. *The acts of the madman, the results of his delusions, are such as no sane man would believe fitted to compass the object in view.*

7. *The violence of the madman is often the effect not of mere passion but of his delusion.*—"I knew no malice," says the author of the autobiography, "no vice. I imagined that they (the keepers) loved me, and were all deeply interested in the salvation of my soul, and I imagined, too, that I loved them dearly. Yet I wrestled with the keepers, and offered to do so with others, and struck many hard blows; sometimes, as one informed me, making it difficult for three strong men to control me; yet whenever I did this, I was commanded, that they wished me to do so, to prove my faith and courage, but that they were commanded to prove both till they were satisfied of my sincerity." "It was always a great delight to me to get my hand at liberty, even for a moment, and the first use I usually made of it was to strike the keeper who untied me; directed by my spirits to do so, as the return he desired above all things else, because he knew I was proving my gratitude to the Lord Jehovah at the risk of being struck myself." Doubtless the keepers regarded this as mere senseless and motiveless violence. Do we not equally misunderstand the criminal acts of the lunatic?*

8. *The maniac, if of a reserved disposition, or when impelled by a strong motive, can conceal his delusion.*—The proof of this proposition may be found in every work on insanity; and a remarkable illustration of it was given by Erskine in his defence of Hadfield. A person who had been confined in an asylum prosecuted his brother and the proprietor for imprisonment and false duress: Erskine was informed that the man was undoubtedly insane; but he was not told of the particular form which the malady assumed. The prosecutor, himself a witness in support of the indictment, was put into the witness-box and examined;

* These statements, like others in this instructive autobiography, are singularly in keeping with those of a recovered religious maniac who was for a long period under our observation.

and when Erskine came to cross-examine him, he found his evidence clear, distinct, collected, and rational. He tried to discover some lurking alienation of mind; but during a cross-examination, conducted with all the skill and sagacity of which he was master, for nearly an hour, he was completely foiled: the answers were perfectly rational—there was not the slightest appearance of mental alienation. But a gentleman who had been accidentally detained, came into court, and whispered in Erskine's ear that the witness thought he was the Saviour of mankind. On receiving the hint, Erskine made a low bow to the witness, addressed him in terms of great reverence, respectfully begged to apologize for the unceremonious manner in which he had treated a person of his sacred character, and called him by the name of Christ. The man immediately said, "Thou hast spoken truly: I am the Christ!" Pinel relates a similar case. A commission appointed to visit the prison of the Bicêtre, examined one particular patient repeatedly upon many successive days; but all their endeavours to prove him insane failed. They accordingly ordered a certificate to be prepared for his liberation; and placed it before him for his signature. He signed "Jesus Christ." In a case to which we have already referred (p. 197), we have reason to believe that more than one of the patient's delusions was never mentioned to any one but ourselves, and that only once; nor could he be induced by long conversations framed for the purpose to give the slightest indication of them to third parties. And a lady who, among other delusions, believed herself Queen of England, spoke on the subject only to one of her sisters. It was only by listening at the open door that we could obtain evidence of the fact.

9. *The acts of the maniac often evince the same forethought and preparation as those of the sane.*—A patient under confinement in the Manchester Lunatic Asylum, had been cruelly treated by a keeper, and in revenge killed him. He related the particulars of the transaction to Dr. Haslam with great calmness and self-possession. He said: "The man whom I stabbed richly deserved it. He behaved to me with great violence and cruelty; he degraded my nature as a human being; he tied me down, handcuffed me, and confined my hands much higher than my head, with a leathern thong; he stretched me on the bed of torture; after some days he released me. I gave him warning; for I told his wife I would have justice of him. On her communicating this to him, he came to me in a furious passion, threw me down, dragged me through the court-yard, thumped me on my breast, and confined me in a dark and damp cell.

Not liking this situation, I was induced to play the hypocrite. I pretended extreme sorrow for having threatened him, and, by an affectation of repentance, prevailed on him to release me. For several days I paid him great attention, and lent him every assistance. He seemed much pleased with the flattery, and became very friendly in his behaviour towards me. Going one day into the kitchen, where his wife was busied, I saw a knife; this was too great a temptation to be resisted: I concealed it about my person, and carried it with me. For some time afterwards, the same friendly intercourse was maintained between us; but, as he was one day unlocking his garden door, I seized the opportunity, and plunged the knife up to the hilt in his back."

10. *The maniac, in spite of his proverbial cunning, is easily imposed upon.*—Of this, which forms the great safeguard of the sane in their dealings with maniacs, a good illustration is contained in Lockhart's 'Life of Sir Walter Scott.' Henry Weber, Scott's protégé and amanuensis, had been reproved by him for indulging in habits of intoxication, which injured his health and interfered with his literary pursuits. On the evening after his return from Edinburgh, Scott observed Weber's eye fixed upon him with an unusual solemnity of expression. On inquiring after his health, Weber rose and said: "Mr. Scott, you have long insulted me, and I can bear it no longer. I have brought a pair of pistols with me, and must insist on your taking one of them instantly;" and with that he produced the weapons, which had been deposited under his chair, and laid one of them on Scott's manuscript. "You are mistaken, I think," said Scott, "in your way of setting about this affair—but no matter. It can, however, be no part of your object to annoy Mrs. Scott and the children; therefore, if you please, we will put the pistols into the drawer till after dinner, and then arrange to go out together like gentlemen." Weber answered with equal coolness, "I believe that will be better," and laid the second pistol also on the table. Scott locked them both in his desk, and said: "I am glad you have felt the propriety of what I suggested—let me only request further that nothing may occur while we are at dinner to give my wife any suspicion of what has been passing." Weber again assented, and Scott withdrew to his dressing-room, despatched a message to one of Weber's intimate companions, and had the maniac secured and placed in confinement.

11. *Maniacs in confinement are often conscious of their state, and know the legal relations in which it places them.*—An intriguing, unruly, vicious madman was detected with a piece of iron, which he had contrived to shape like a dagger, and fix in a

handle. When the weapon was taken from him, he became excessively abusive, and had to be placed under restraint. In the fit of fury which followed, he uttered the most revolting imprecations, and exclaimed to the keeper, "*I'll murder you yet: I am a madman, and they cannot hang me for it.*" When Martin set fire to York Minster, the inmates of a neighbouring madhouse discussed the question whether Martin would suffer the extreme penalty of the law. Various opinions were expressed; but in the midst of the conversation, one patient, apparently as mad as the rest, exclaimed, "He (Martin) will not be hanged—of course he will escape." "For what reason?" asked several voices. "They cannot hang him," replied the lunatic, "because he is mad,—*he is one of ourselves!*"* It is important to understand that this consciousness of their state belongs only to madmen surrounded by madmen in lunatic asylums, or to those who have been under treatment.

The foregoing are some of those leading characters of mania which bear on the decision of medico-legal questions. They serve to throw light upon the the phenomena of insanity, and to answer some of the arguments advanced by persons ignorant of the real nature of this strange condition of mind.† To the better informed, they may be useful by setting forth more clearly than any general description could do, the contradictions of which the madman is the sport. It is probably beyond the power of the sane mind to conceive the confusion which reigns in the mind of the madman. A series of delusions, the offspring of some one excited passion or emotion, or one single delusion, the work of fancy, the interpreter of every sensation, the source of every thought, the mainspring of every action; holding every faculty in stern subjection, making the senses its dupes, the reason its advocate, the fancy its sport, the will its slave; now whispering in the ear things unspoken, now painting on the eye things unseen; changing human beings at will into fiends or angels; converting every sensation into a vision, every sound into articulate speech; the unreal world within in constant conflict with the real world without; understood of no one, yet believing himself to be comprehended by all; punished for the very acts which he believes his tyrants to have commanded, controlled in everything which he thinks it his duty to perform. There is no wish however presumptuous, no fancy however monstrous, no action however absurd, no crime however heinous, that his delusion cannot create, prompt, and justify.

* Winslow's 'Plea of Insanity in Criminal Cases,' pp. 16, 17.

† For a very able exposition of some of the characters of mania, see Abercrombie, 'On the Intellectual Powers,' 9th edition, pp. 315 and 326.

The degree of confusion existing in the mind of the madman will, of course, vary with the nature and extent of his delusions. When several spring from one excited emotion or passion, such as pride, vanity, or religious veneration, the distraction must be greater than when one single delusion takes possession of the mind.

Legal relations of Mania.—There is a difference worthy of note between the effect of mania on civil and criminal acts. In civil cases, if a man can be shown "to be *non compos mentis,* the law avoids his act, though it cannot be traced to, or connected with, the morbid imagination which constitutes his disease, and which may be extremely partial in its influence on conduct."* But in criminal cases, it is not enough to prove a man *non compos:* it must be shown that at the time he committed the act he did not know right from wrong. It is not easy to understand the reason of this distinction. If it be just to deprive a man of the management of his property on account of a delusion which has no immediate connection with the affairs of business, ought not the same delusion which renders him incapable of civil acts, to render him also incapable of crimes? Do not the same faculties concur in civil as in criminal acts? Is there not in both some wish or emotion or passion to originate the act, reason, or instinctive cunning, to plan it, and will to execute it? The civil acts of a maniac are not void on account of the direct effect of his delusion upon them, but because there is no security that the influence of the delusion may not at any moment extend beyond its usual sphere of action. It is just so with his criminal acts. The delusion which ordinarily affects only the intellect, or shows itself in harmless peculiarities of conduct, may lead to acts of atrocious violence; and it is but reasonable to suppose that the mind which is so excited or perverted that it can oppose no effectual check to delusive ideas, is equally unable to offer effectual resistance to a criminal impulse. The importance of this subject will justify a more lengthened examination of it.

The plea of Insanity in criminal cases.—It is necessary to premise that the plea of insanity may be raised in respect of all such grave offences as homicide, arson, and theft; but as the large majority have been cases of homicide, and almost all the legal discussions of importance have arisen out of them, the remarks that follow must be understood to relate primarily to homicide. It should also be borne in mind that though the plea of insanity may be set up in reference to homicidal acts committed

* Erskine, in his defence of Hadfield: also the judgment of Sir James Wilde in the case of Mrs. Thwaites, August, 1867.

in a maniacal paroxysm, and by persons otherwise rational alleged to be seized with an uncontrollable impulse, the greater number of cases belong to the class of mania with delusion in which the homicidal act has been carefully planned, and carried deliberately into effect.

Our earliest legal authorities evidently confounded mania with idiocy, for Bracton defines a madman as one who "does not understand what he is doing, and, wanting mind and reason, differs little from brutes;" and when the attorney-general, on the trial of Hadfield, in the first year of this century, laid down the law, "that to protect a man from criminal responsibility there must be a *total* deprivation of memory and understanding," Erskine admitted this to be "the very expression used both by Lord Coke and by Lord Hale," and though Lord Hale made a slight step in advance by distinguishing *total* from *partial* insanity, alleging that partial insanity was no excuse in the commission of any capital offence, and suggesting as a measure of responsibility, "that such a person as, labouring under melancholy distempers, hath yet as great understanding as ordinarily a child of fourteen years hath, is such a person as can be guilty of treason and felony," we find Mr. Justice Tracy, in the trial of Arnold, in 1723, for shooting at Lord Onslow, still under the guidance of Bracton, and observing: "It is not every kind of frantic humour, or something unaccountable in a man's actions, that points him out to be such a madman as is exempted from punishment: it must be a man that is totally deprived of his understanding and memory, and doth not know what he is doing, no more than an infant, than a brute, or a wild beast: such a one is never the object of punishment."

The trial of Hadfield gave the death-blow to these narrow and unsound doctrines, and established delusion as the true test of intellectual mania. In conducting the defence, Erskine showed that what the law had styled madness was idiocy—the idiocy *à nativitate vel dementia naturalis* of Lord Hale himself—and that no such madness as that imagined by the older writers had "ever existed in the world." He then succeeded in showing that "delusion, when there is no frenzy or raving madness, is the true character of insanity," but added the very questionable proviso that in order to render the madman irresponsible for crime, it must be shown, that the act in question was the immediate unqualified offspring of the disease.

These new doctrines, though always quoted with approbation, were soon lost sight of, and in place of the test of delusion, sprang up that of "right and wrong." Thus, in the case of Bellingham

tried at the Old Bailey for the murder of Mr. Perceval, May 15, 1812, Mansfield, C. J., is reported to have told the jury that they must be satisfied, in order to acquit, that the prisoner was incapable of judging between right and wrong, and that at the time of committing the atrocious act with which he stood charged, he did not consider that murder was a crime against the laws of *God and Nature.* In a case which occurred only two months later (that of Bowler for shooting Mr. Burrowes), Mr. Justice Le Blanc left it to the jury to determine whether the prisoner, when he committed the offence, was incapable of distinguishing between right and wrong, or whether he was under any illusion in respect to the person he shot, which rendered his mind at the time insensible to the nature of the act he was about to commit; since in that case he would not be legally responsible for his conduct. In a still more recent case (Rex *v.* Offord), Lord Lyndhurst told the jury to acquit, if they were satisfied that the prisoner did not consider his act any crime against the laws of *God and Nature.* A similar principle, with slight and unimportant verbal variations, was affirmed in the trial of Oxford for firing at the Queen, and in the case of M'Naughten, which led to an able exposition of the law by the lord chancellor in the House of Lords, and elicited the opinions of the law lords, and carefully considered answers to certain questions addressed to the judges.

There can be no doubt, then, that the legal test at present received is the power of distinguishing right from wrong. But the difficulty of applying this test in practice is so great that judges often, and juries always, prefer a more easy and reasonable procedure. Thus, in the case of Hadfield, Lord Kenyon, with the concurrence of the rest of the judges of the King's Bench, interrupted the defence, and said that "with regard to the law, as it had been laid down, there could be no doubt whatever. If a man be in a deranged state of mind at the time of committing an act, he is not criminally answerable; the material part of the case is whether, at the very time, his mind was sane." Here, then, the distinction between right and wrong is altogether lost sight of, and the simple practical question of the insanity of the accused is made to take its place. As a general rule, however, the theory and practice of the law have been so far consistent; that though the verdict of the jury has been couched in general terms, the test of right and wrong has been distinctly propounded from the bench. In the case of M'Naughten, for instance, the jury brought in a verdict of "not guilty, on the ground of insanity," after Chief Justice Tindal had in his charge strongly and clearly laid down the distinction of right and wrong.

The state of the law up to a recent date, and, indeed, up to the present time, may be inferred from the answers of the fifteen judges to the questions suggested by the trial of M'Naughten. These questions were submitted to the judges by the House of Lords, and the answers, in which the whole bench, with the exception of Mr. Justice Maule, concurred, were read to the house by Lord Chief Justice Tindal on the 19th June, 1843. From these questions and answers given *in extenso* below,* the present

* Question I. What is the law respecting alleged crimes committed by persons afflicted with insane delusion, in respect of one or more particular subjects or persons: as, for instance, when at the time of the commission of the alleged crime the accused knew he was acting contrary to law, but did the act complained of with the view, under the influence of some insane delusion, of redressing or avenging some supposed grievance or injury, or of producing some supposed public benefit?—Answer. *The opinion of the judges was, that, notwithstanding the party committed a wrong act, while labouring under the idea that he was redressing a supposed grievance or injury, or under the impression of obtaining some public or private benefit, he was liable to punishment.*

Question II. What are the proper questions to be submitted to the jury, when a person alleged to be affected with insane delusion, respecting one or more particular subjects or persons, is charged with the commission of a crime (murder, for example) and insanity is set up as a defence?—Answer. The jury ought in all cases to be told that every man should be considered of sane mind until the contrary were clearly proved in evidence. That before a plea of insanity should be allowed, undoubted evidence ought to be adduced *that the accused was of diseased mind, and that at the time he committed the act he was not conscious of right and wrong.* This opinion related to every case in which a party was charged with an illegal act, and a plea of insanity was set up. *Every person was supposed to know what the law was, and therefore nothing could justify a wrong act except it was clearly proved that the party did not know right from wrong.* If that was not satisfactorily proved, the accused was liable to punishment; and it was the duty of the judge so to tell the jury when summing up the evidence, accompanied by those remarks and observations which the nature and peculiarities of each case might suggest and require.

Question III. In what terms ought the question to be left to the jury as to the prisoner's state of mind at the time when the act was committed? No answer.

Question IV. If a person, under an insane delusion as to existing facts, commits an offence in consequence thereof, is he hereby excused?—Answer. *If the delusion were only partial, the party accused was equally liable with a person of sane mind. If the accused killed another in self-defence, he would be entitled to an acquittal; but if the crime were committed for any supposed injury, he would then be liable to the punishment awarded by the laws to his crime.*

Question V. Can a medical man, conversant with the disease of insanity, who never saw the prisoner previously to the trial, but who was present during the whole trial and the examination of all the witnesses, be asked his opinion as to the state of the prisoner's mind at the time of the commission of the alleged crime, or his opinion whether the prisoner was conscious, at the time of doing the act, that he was acting contrary to law? or whether he was labouring under any, and what delusion at the time?—Answer. The question could not be put in the precise form stated above, for by doing so it would be assumed that the facts had been proved. When the facts were proved and admitted, then the question as one of science would be generally put to a witness under the circumstances stated in the interrogatory.

Mr. Justice Maule dissented from the answer to this last question. In his

state of the law in respect of homicidal acts, committed by persons afflicted with mania accompanied by delusions, may be inferred to be as follows:—1. That a person who commits an act under the influence of an insane delusion, with a view of avenging some supposed injury, redressing some supposed grievance, or producing some supposed public benefit, is liable to punishment, if, at the time of committing the act, he knows that it is contrary to law. 2. That if the delusion is only partial, the responsibility incurred is equal to that attaching to a person of sound mind. 3. That before the plea of insanity can be allowed, it must be proved in evidence that the accused was of diseased mind, and that at the time of committing the act he was not conscious of right and wrong. 4. That he is assumed to know what the law is, and is only held irresponsible for his act if his mind can be shown to be so unconscious of right and wrong that he is incapable of appreciating the law and its requirements. This is the only reasonable interpretation which can be given to the doctrine of the judges. "Every person was supposed to know what the law was, and *therefore* nothing could justify a wrong act, except it was clearly proved that the party did not know right from wrong."

Four distinct questions are suggested by this brief summary of the decisions of the fifteen judges. 1. Are the class of maniacs now under consideration (namely, those who commit acts of violence under the influence of delusions, and with premeditation) cognizant of the law? 2. Can they distinguish right from wrong? 3. Do the answers to these questions apply to persons subject to *partial* delusions? 4. Are these legal and moral tests of any practical utility?

1. *Are maniacs, who commit premeditated acts of violence under the influence of delusions, cognizant of the law?*—The answer to this question is easy. There is every reason to believe that these persons possess the intelligence and consciousness requisite to the knowledge and appreciation of the law. They have been shown to be as a class by no means wanting in memory, observation, or reasoning power. Some of them have committed murder that they might suffer the penalty of the law. Those who, from being placed under restraint, have grown conscious of their infirmity, know or believe that they are by that infirmity rendered irresponsible, and it is in the last degree improbable that monomaniacs whose intellects appear so little affected that they are allowed to mingle in society like other men, should be ignorant of a law with

opinion such questions might be at once put to medical men without reference to the facts proved; and he considered that this had been done, and the legality of the practice thereby confirmed on the trial of M'Naughten.

which from their earliest years they have been familiar, and of which we are all, unfortunately, too often reminded. The knowledge and consciousness of this law may be fairly expected to be the very last of which madness would deprive a man.

2. *Can they distinguish right from wrong?*—The class of maniacs now under consideration are probably quite conscious of the difference between right and wrong, and if asked whether murder is an offence against law, divine and human, would answer unhesitatingly in the affirmative. But there is equal reason to believe that if a maniac subject to delusions were to conceive a desire to murder, he would be as incapable of resisting that desire as he had already proved himself incapable of resisting his delusions. There is a fair and reasonable analogy between the insane thought and the insane wish. His delusions have already defied the evidence of his own senses, the efforts of his own reason, the testimony of his sane neighbours, and the remonstrances of his friends; and his impulses will probably prove as irresistible when confronted with his knowledge of the distinction between right and wrong and the remonstrances of his conscience.

3. *Of partial delusions.*—A maniac subject to a great number of delusions would naturally be less able to control his irregular impulses than one who has but one or two. A multitude of delusions naturally implies more confusion and more excitement. Single delusions may be supposed to be more compatible with self-restraint; but they are of rare occurrence, and do not often figure in courts of law. *Partial delusions* are much more common, but when they are closely examined they are found to be the offspring and natural expression of some one excited feeling or passion, which, having had force enough to create illusions of the senses and delusions of the mind, may be expected to give rise to insane impulses of great power.

The excited feelings or passions which, having first destroyed the integrity of the senses and mental faculties, proceed to instigate acts of violence and cruelty, are religious excitement or despondency; jealousy; domestic anxieties exaggerated into fear of starvation; and discontent transformed into an insane belief in persecution. Now the acts of violence which ultimately flow from these excited feelings or passions, after they have given rise to a series of delusive ideas, ought to be judged by the same rules which apply to the delusions themselves. The acts are probably as little subject to restraint as the delusions to correction.

We will consider these four sources of homicidal acts separately.

Maniacs under the influence of religious excitement or despondency are subject to illusions and delusions of a very singular

kind. They transform the persons with whom they are associated into supernatural beings, endowed with authority or power not to be questioned or resisted; and they convert common and familiar sounds into the articulate language of temptation or command. One religious maniac, therefore, kills a relative or a keeper, imagining him to be a fiend; another thinks that he has a direct commission from the Deity to fulfil some mission of wrath or extirpation. In cases of religious mania, then, we can never safely affirm that the homicidal act was not the natural consequence of a command which the maniac would deem it impious to resist, or of a delusion which places him in his own sincere conviction beyond and above the operation of human laws. The maniac who believes himself to be God, Christ, or the Holy Ghost, would, from the very nature of the case, deem himself irresponsible to human laws.

Of homicidal acts instigated by jealousy shaping itself into a distinct delusion it will suffice to observe that they are such acts as if committed by sane men on the evidence of their senses, would be punished as manslaughter and not as murder.

Of the fathers and mothers who kill their children under the pressure of domestic anxiety culminating in an insane dread of starvation, it may be observed that they are generally remarkable for their domestic virtues and devoted attachment to their victims, and that between them and ordinary murderers there is no single point of resemblance.

Discontent, transformed into an insane belief in persecution, presents greater difficulties. The case is generally put in a form which seems to preclude a satisfactory answer. A maniac believes himself to have been injured by another, and he kills him. If the injury were real, the murderer would be responsible, and so, it is contended, ought the madman to be. This curiously illogical argument ignores the simple fact that the two cases have nothing in common but the act itself. The imaginary offence has imaginary accompaniments, and every thought connected with it is one of confusion. To suppose that a mind which can imagine an impossible offence is sound in all other respects is to outrage common sense, and set at nought the experience of all who have knowledge of the insane. They all with one consent repudiate the notion of a mind subject to such a delusion being sound, and free to act as it will, beyond the sphere of its influence. The more closely the victim of this partial delusion is observed, the more extensive is found to be the disorder of his intellect. His actions which are not directly prompted by his delusion are more strange, and his passions more excitable than those of other men.

The theory of a single insane idea, unaccompanied by any other disordered action of the faculty from which it takes its rise, having no effect upon the remaining faculties, and showing itself simply by prompting an action which, once suggested, is carried out with the same complete consciousness of its real nature as exists in the mind of a sane man acting under the suggestion of a corresponding reality, is too absurd to be for one moment entertained. Even in this case, then, the question of responsibility cannot be decided by the simple test of a knowledge of right and wrong.

But there is another case allied to the one now under consideration which presents still greater difficulties. A man receives a real injury, and avenges himself; but it is alleged that he was not of sound mind when he committed the act. The unsoundness of his mind is admitted, but he is deemed responsible because he was instigated by the common motive of revenge. On the other hand, it is reasonable to allege that the real injury has been by his insane mind magnified to undue importance, and then acted upon just as if it had been altogether imaginary; and that he is therefore neither more nor less responsible for his act than the man whose motive was from the very first in the nature of a delusion. In this case, too, an inquiry into the state of the mind, extending much beyond the legal test, will be necessary, and cannot be refused; and this, once granted, must result in showing the insufficiency of the test. Even in those cases where the criminal act cannot be traced to any delusion of which it is the legitimate offspring, but it is simply alleged in defence that the party is of unsound mind, the very fact of the unsoundness becomes an irresistible plea in mitigation. It would be strange, indeed, if the case of the maniac under the accusation of crime were the only one in which such a plea is ignored and refused.

4. *Are these legal and moral tests of any practical utility?*—If the utility of a test is to be measured by the facility of its application, this test of a knowledge of right or wrong will certainly be condemned. It fails in the hands of the medical witness; it is often practically set aside by our judges; and it is never really applied by our juries, as the very form of their verdicts shows. In most cases it is as easy to ascertain the fact of unsoundness of mind as it is difficult to determine its precise effect on the madman's acts. But it is eminently absurd to credit a mind which is already occupied by delusions with an otherwise efficient state of its faculties. It is in the highest degree improbable that a mind so possessed is able, beyond the sphere of its delusions, to think, feel, and act with the clearness, force, and freedom of the sane.

Some writers, under a strong sense of the failure of the legal test of a knowledge of right and wrong, have sought to set up in its place the power of control or restraint. The test has been thus transferred from the intellect to the will—from the knowledge of right to the power of acting aright. But this is a mere shifting of the difficulty; for it is obviously quite as easy to ascertain a man's abstract knowledge of right and wrong, lawful and unlawful, as to measure the exact amount of self-restraint which he possesses.

This test appears to have this advantage over the knowledge of right and wrong, that the very mode of accomplishing the homicidal act affords some measure of the amount of restraint or self-control which the maniac is able to exert. If he watches his opportunity, bides his time, prepares a fitting instrument, and uses it in the ordinary way, it is inferred that he possessed such an amount of self-control as ought to have prevented the murderous act.

But the objection to this test is obvious. It is drawn from the analogy of the madman's sensations and thoughts. If he could not prevent the senses from being the sport of illusions, and was unable to root out delusions from his mind, it is not to be supposed that he can control the irregular impulses and passions which are to the will what illusions are to the senses or delusions to the intellect. And if it is alleged that the skill evinced in planning the homicidal act, and the patience shown in waiting for a favourable opportunity, ought to be taken as evidence of adequate self-control, appeal may again be made to analogy. The acts of the maniac are in strict keeping with his thoughts. His delusions, even when they are most distinctly present to his mind, are quite compatible with the exercise of all his faculties. If they are attacked, he defends them acutely, and justifies them plausibly. They have not destroyed his faculties, they have merely perverted them to a wrong use. So is it with his homicidal act. The impulse which seizes upon his unsound mind does not destroy its powers, it merely perverts them.

Accordingly, if a maniac is under the delusion that his keeper is a fiend, or if he believes that the Deity has commissioned him to take away his life, he will secrete and sharpen a knife, watch his opportunity, and act in every respect as a sane criminal would do. And, if prevented, he will wait for a more favourable occasion. Nay, the merest imbecile knows that a knife or a pistol is a common instrument of death; and weak as his mind may be, he conceals his weapon, not because he is conscious of guilt, but because he knows that, if it were openly displayed, the action he

contemplates would be prevented. The fact is, that in proposing this test, as in the general discussion of this question, two distinct things have been confounded—the act itself, which is the result of the delusion, and the mode of accomplishing it. It is the delusion which distinguishes the madman, and not the mode in which the delusive impulse is carried into effect.

The difficulty of devising a test which shall not be open to the most serious objections, has led some persons to invent an easy method of escape, by depriving persons of unsound mind of what they call the privilege of insanity, or, in other words, refusing to entertain the question of the state of the mind at all. This suggestion may have the merit of simplicity, but it is open to the serious objection that it could be acted upon only once. The spectacle of a madman on the scaffold would be simply intolerable. No jury could be found to convict; and the indiscriminating statute would prove as complete a dead letter as the statute which awards the punishment of flogging to assaults upon the Queen did, when it was to be applied to the person of poor Lieutenant Pate. The idea of hanging and flogging madmen is utterly repulsive, and must be given up.

Another theory propounded by some writers of eminence is, that as madmen are, like other men, influenced by fear, the punishment of death as the consequence of murder, should be kept before their eyes. This theory may be said to have broken down in the case of Lieutenant Pate, just referred to. It is most probable that this poor imbecile was cognizant of the degrading punishment awarded by a recent statute to persons who should assault the sovereign; but the threat had no effect upon him. By parity of reasoning, it seems most probable that the threatened punishment of death would prove equally ineffectual in every class of madmen. But, in reality, the restraining influence of the punishment of death is already brought to bear; for it should be borne in mind that men who have not been certified as insane, and confined in lunatic asylums, do not believe themselves to be mad. They are, in their own sight, sane men. It is only after men have been taught, by confinement as madmen, that they are insane, or are believed to be so, that the terror of the gallows is replaced by the alternative terror of perpetual imprisonment.

Those who maintain the theory now under examination are apt to defend it by comparing persons of unsound mind with the lower animals, alleging that, as dogs can be weaned by punishment from practices distasteful to their masters, so madmen can be deterred from crime by fear of death.

In putting forward this argument from analogy two facts are

overlooked—the fact that the animal has been punished, and has a distinct recollection of the pain inflicted upon him, while the madman has been merely threatened; and the fact that there are many dogs who cannot be weaned from bad habits by the frequent repetition of the most severe chastisement. In the case, then, of the class of maniacs now under consideration, who, being subject to delusion, commit their acts of violence with premeditation, it is submitted that all the legal and moral tests are inapplicable and useless; and that the law of England ought to be assimilated to that of France—"Il n'y a ni crime ni delit lorsque le prévenu etait en état de démence au temps de l'action."

It may be objected that under such a law, unless the most rigid proof of insanity were required, some men would escape who ought to suffer the punishment of death; but, on the other hand, none who did not deserve death would be executed; and it is a generally acknowledged principle, that it is better that many guilty persons should escape than that one innocent man should suffer. Moreover, a verdict of acquittal, on the ground of insanity, brings with it, as a necessary consequence, confinement for life, which, were it inflicted as a punishment, would hardly be second in severity even to death itself. Nor is there any good reason to fear that, by exempting the madman from the punishment of death, we shall weaken the hold which the law has on the man of sound mind; for, in order that he may escape death, he must successfully feign insanity—a task of no ordinary difficulty—and, if he succeed, a perpetual sacrifice of liberty awaits him. It is not likely, therefore, that society will suffer any injury from the adoption of the course here advocated; and we may perhaps find that it gains something by openly attributing to disease some of the most revolting acts which degrade and debase our common nature.

In respect to the responsibility of madmen, then, the law seems to be in this dilemma;—it must either insist upon a test which it is impossible to apply, or it must uniformly refuse or admit the plea of insanity. If it hold to a test, its decisions will want that uniformity which ought to belong to them, and their soundness will be constantly liable to be called in question; if it reject the plea of insanity, it ought forthwith to do away with all other pleas in mitigation.

The foregoing observations apply to those cases only in which distinct proof has been obtained of unsoundness of mind, existing previously, as well as at the very time of the criminal act, and not to that instinctive madness which is altogether independent of the intellect, and consists merely in uncontrollable impulse.

This form of madness is now generally recognised by medical men as *instinctive* or *impulsive* mania, and has on more than one occasion led to the acquittal of an accused party.

The criminal acts committed under its influence have most or all of the following characters: They are without discoverable motive, or in opposition to all known motives. A man kills his wife, to whom he is tenderly attached; a brother his sister; a mother her infant; or the victim is one whom the madman never saw before in the course of his life, and against whom it is impossible that he can bear any malice. After the commission of the act, he does not seek to escape; he often publishes what he has done; does not conceal the body from view, but openly exposes it; delivers himself up to justice; describes the state of mind which led to the act, and either remains stupid and indifferent, or is overwhelmed by remorse. He has no accomplices, has made no preparations, and takes nothing from his victim. Sometimes he has previously spoken of his strong temptation, and begged to be prevented from doing mischief. These homicidal acts are generally preceded by a striking change of conduct and character, and, on inquiry, the accused is often found to have an hereditary tendency to insanity, to have attempted suicide, to have expressed a wish for death, or to be executed as a criminal. In this class of cases, it is most important that all the circumstances should be duly weighed, and that careful search should be made after those motives which most frequently actuate the criminal.

It is in such difficult cases, too, that a caution is especially necessary against basing a decision upon one or two alleged characteristics. All the circumstances of the act ought to be duly weighed, in the spirit of the words of Lord Hale: "lest, on the one side, there be a kind of inhumanity towards the defects of human nature, or, on the other side, too great an indulgence given to great crimes." This instinctive madness is no doubt sometimes associated with delusions, the criminal act itself being the result of strong excitement of the passions, while the delusions suggest the motive. To this class probably belong those cases of wholesale murder in which the father of a family destroys his wife and children, to prevent them from falling victims to starvation, and then puts an end to his own life; the idea that such an evil threatens them being insane, no less than the impulse which prompts such a mode of escape.

Violent homicidal impulses are very common in the *epileptic*, sometimes preceding, sometimes following the paroxysms, and sometimes also taking their place, in which latter case the attack

is described as *masked epilepsy.* The following cases are instructive :—

A shoemaker, subject to epilepsy, was often furious for some time after the fits, but sensible, amiable, and industrious in the intervals. One day, when in the gloomy and morose state of mind that often precedes a fit, he met the superintendent of the asylum, to whom he was much attached, and stabbed him to the heart. He had not had a fit for three weeks, but the night following the homicide he had a severe fit, and for some time the attacks continued to be frequent and severe.

A peasant suffered from epilepsy from his eighth to his twenty-fifth year, when, instead of epileptic attacks, he was seized with an irresistible impulse to kill. He felt the approach of his attack sometimes for days beforehand, and begged to be restrained. "When it seizes me," he said, "I must kill some one, were it only a child." Before the attack he was very weary and depressed, could not sleep, and had slight convulsions of the limbs.*

In order to complete this inquiry into the plea of insanity in criminal cases, the following sketch of the different aspects given to homicidal acts by the several varieties of unsound mind is submitted :—An imbecile has a confused and imperfect notion of crimes, laws, and punishments ; and his acts are as foolish as his thoughts. The case referred to at p. 178 is a good example of this class. A monomaniac fancies himself an object of persecution, and he kills one of his imaginary tormentors, hoping thereby to rid himself of all ; an act as mad as the thought which inspired it. Such was McNaughten. Another, having betrayed decided symptoms of madness, receives a real injury and kills the offender. Such was Lord Ferrers. A third, oppressed with melancholy fears, kills those to whom he is most attached, to save them from some imaginary fate. Such was the female already referred to, who, under the fear of starvation arising out of temporary difficulties, killed her child, cooked it, ate of it, and offered the dish to her husband. Lastly, we have the so-called instinctive madness, of which the case of William Brown, given at length in Ray's 'Medical Jurisprudence of Insanity,' affords a good example.

V. FEIGNED UNSOUNDNESS OF MIND.

Men feign insanity from the same motives which lead to the simulation of other diseases, and it is specially true of this class,

* Quoted from Marc by Maudsley ('Physiology and Pathology of the Mind,' p. 309).

that it is only by actual experience of the real disease that, in difficult cases, the counterfeit can be detected.

Idiocy.—This is rarely assumed, and, when feigned, is easy of detection. The idiot has almost always the defective formation of head, face, and person pointed out at p. 172; and it must always be practicable to learn so much of an impostor's history as that he was not always in the condition which he has assumed.

Imbecility.—In this case, too, the history, where it can be obtained, will assist in unmasking the imposition. The peculiar cast of countenance of the imbecile is extremely difficult to imitate. The stupid, vacant, and wandering look, the unsettled and uneasy manner, the disconnected and evanescent ideas, the variable temper and spirits, the sudden and transient gusts of passion, and the foolish and childish acts, are, collectively, very difficult to assume. In the less strongly-marked forms of real imbecility, folly and acuteness are displayed indifferently on all subjects; but the impostor is shrewd on those which involve his interest or the success of his scheme, and displays his stupidity only in matters of indifference.

This class of cases, however, it must be admitted, presents unusual difficulty of diagnosis, and gives rise to great differences of opinion among medical men. We have had under our notice several cases of imbeciles certified as insane by the medical officers of prisons, and returned from the asylums as impostors; and other cases in which, after long and careful observation under most favourable circumstances, two equally competent observers have not been able to agree in their opinion. Unsettled habits, wandering and disconnected thoughts, sudden bursts of passion, unprovoked acts of violence, unsuccessful attempts at suicide, transient and half-formed delusions, short fits of industry, handiwork displaying much skill and ingenuity, make up a combination which it would be in the power of a good actor to assume. But imbeciles of this order possess sufficient shrewdness and self-control to conceal and moderate their eccentricities when they have an object to accomplish. So that it is quite possible for a real imbecile in prison to seem an impostor in an asylum. Nor must it be forgotten that the previous lives of these persons have been one continuous history of deception, and of shifty devices for living without work.

Dementia.—This form of unsoundness is rarely imitated, that torpor of all the faculties which belongs to the true disease being hard to assume and sustain; and we may be assisted in our diagnosis by discovering marks of the form of paralysis which attends one form of chronic dementia. Here, too, we may encounter a

difficulty of diagnosis arising out of the rare obstinacy with which a prisoner—a female especially—will maintain a weak expression of countenance, repeat a few silly expressions, pass the excreta as if involuntarily, and resist every test that it is possible to apply. Such a malingerer may never have deceived the medical observer for a moment; but he may be compelled to wait patiently for a confession of the fraud.

Mania.—As it is more easy to assume the violence of mania than the more subdued characters of the foregoing forms of unsoundness, mania is more frequently feigned. The distinction between the fictitious and the true disease, though occasionally requiring time and continued observation, is not difficult; but in this, as in other feigned diseases, the impostor often obstinately resists the efforts of the medical man to obtain a confession of his fraud.

The peculiar intense expression of countenance, the marked alteration of the features, and the wildness of the eye of real mania, are very hard to assume and maintain. The violent excitement, the loud shouts, the strong struggles and convulsive movements of the paroxysms, also scarcely admit of imitation, and cannot be supported for any length of time. The real maniac will continue without sleep for days, and even weeks, or, if he sleep at all, his rest will be disturbed and agitated; but the impostor can scarcely keep awake beyond one or two days, and a dose of opium, which would produce no effect whatever on the madman, would infallibly send the impostor to sleep. The same remark applies to other remedies, such as emetics and purgatives. The madman will also go without food for days together with impunity, and with little loss of strength, and is so insensible to external impressions that he will bear the most intense heat or cold, and gaze, without being dazzled, on the strong light of the sun. Other symptoms of less importance have been insisted on, such as the torpid state of the bowels, the moderate or low temperature of the trunk and limbs, a peculiar odour of the skin, and a frequent pulse.*

To this account of the physical signs of mania, it may be added that the impostor will overact his part during such times as he is watched; that instead of becoming more quiet and reserved on the approach of the physician, his violence increases; that he assumes a want of intelligence instead of that perversion of

* In the first edition of this work facts were adduced to show that the value of the pulse as a diagnostic mark had been exaggerated All, perhaps, that can be safely affirmed is that an infrequent pulse, which often exists in healthy persons, would scarcely be compatible with mania.

reason which is so characteristic of the real affection; that he obtrudes instead of concealing his thoughts; that he pretends a defect of memory and apprehension which does not belong to real insanity, gives false answers to questions, and affects not to recognise persons whom he knows; that he does not recur constantly to the leading idea; that he betrays hesitation in the midst of his assumed violence; that he has not the steady gaze of the madman; that his fits occur suddenly and at irregular and convenient intervals, instead of having the periodicity of intermittent attacks of mania. It may be added, that instead of having a period of incubation so general in true mania, the first attack of his disorder is sudden. That perversion of the moral feelings which causes the madman to dislike every person to whom he was previously attached, being a symptom little known to the vulgar, is also not assumed by the impostor. Besides the diagnostic marks to be gleaned from the foregoing description, and the precautions already mentioned under the head of feigned diseases, some special tests have been recommended, such as repeating to the suspected person a series of ideas recently uttered, when the real maniac will introduce new ideas, but the impostor will repeat the same words. The use of the whirling chair has also been recommended, as producing giddiness and nausea in the impostor.

Partial Intellectual Mania.—Monomania, Melancholia.—These partial forms are less frequently feigned than general mania, or raving incoherence, and rarely with success. Many of the characters of mania already described, are present in cases of intellectual mania springing out of some excited emotion, such as pride or vanity. There is the same irritability of temper, the same violent prejudices, the same unfounded aversions and equally unfounded attachments, the same sleeplessness, the same insensibility to impressions, and to the operation of medicines. The pretended monomaniac makes a more open display of his assumed delusion than the real monomaniac, who rarely solicits attention. The true monomaniac is generally reserved, taciturn, and indifferent, but is easily excited and angered by opposition and argument. When hard pressed, men generally take refuge in violence, and women in tears.

The forms of intellectual insanity most commonly assumed, and most difficult to distinguish, are those which consist in the assumption of a single delusion, or of profound melancholy; and it is obviously difficult to lay down any diagnostic marks by which the real disease can be distinguished from the false.

The difficulty of diagnosis is seriously enhanced when, as some-

times happens, the malingerer is a good actor, and makes a faithful copy of the words and acts of a madman with whom he has been brought in contact in or out of an asylum.

Moral Mania, General and Partial.—General moral insanity, consisting of a strange combination of foolish, obscene, and cruel acts, may have to be distinguished from mere wickedness: but it is not apt to be assumed. To distinguish moral insanity from vice may sometimes be difficult; but, as a general rule, there is a strangeness and variety in the acts of the madman which does not belong to those of the sane criminal. As the character of the act or acts committed is the chief ground for believing in the existence of partial mania, there is no certain means of distinguishing the real from the feigned disease. It is, however, so unlikely that a sane man would be guilty of an act for which no motive can be discovered, with the certainty of being severely punished if found sane, and imprisoned for life if pronounced mad, that we may fairly assume such an act, if accompanied by all or many of the characters already pointed out, to have been the result of real moral insanity. The personal and family history of the accused would also afford some presumptions in favour of or against the theory of insanity.

Concealed Insanity.—The power of concealing his delusions, under the influence of a sufficiently strong motive, has already been shown to belong to the madman; and long-continued observation, repeated interrogations, and careful inquiry into the patient's previous history may be necessary to bring the delusions to light.

VI. RULES FOR THE EXAMINATION OF PERSONS SUPPOSED TO BE OF UNSOUND MIND.

The main points to be attended to in the several examinations which the medical man may be required to institute, are the following:—

1. Observe narrowly the general appearance and the shape of the head; the complexion and expression of the countenance; the conformation of the body; the gait and movements, and the speech.

2. Ascertain the state of the general health, of the appetite, and digestion, of the bowels, of the tongue, skin, and pulse. Note especially the presence or absence of febrile symptoms, as an important aid in distinguishing delirium from madness. Ascertain whether there is sadness or excitement, restlessness or stillness, and whether the sleep is sound and continuous or disturbed and

broken. In females the state of the menstrual functions should be inquired into.

3. The *family history* should be traced out, in order to ascertain whether there is any hereditary predisposition to insanity, whether any members of the family have been subject to fits, or have betrayed marked eccentricity of behaviour.

4. The *personal history* should be ascertained with equal care. If the mind appears unsound, ascertain whether the unsoundness dates from birth, or from infancy, or from what time. If the unsoundness has supervened later in life, whether it followed any severe bodily illness, accident, mental shock, long-continued anxiety of mind, repeated epileptic fits, or indulgence in habits of intemperance.

5. Inquire whether the present state of mind differs materially from that which existed when it was reputed to be sound; and whether the feelings, affections, and domestic habits have undergone any marked change.

6. Ascertain whether the existing unsoundness is a first attack, and if so, whether it began with depression or excitement; if not, what were the characters of the first attack. Did it follow a period of melancholy, pass into mania, and then into slow convalescence? Has the patient suffered from epilepsy? If any signs of general paralysis are present in the speech or gait, has the patient squandered his money, grown restless, and wandered about, exposed his person, committed petty thefts, or had illusions of wealth and grandeur?

7. When the object we have in view is to ascertain the capacity of the mind, it must be tested by conversation directed to such matters as age, the birth-place, profession, or occupation of parents, number of brothers, sisters, and near relations, common events remote and recent, the year, the name of the month, and the day of the week, the name and family of the sovereign, and of persons best known and most talked of. The power of performing simple operations of arithmetic, and the knowledge of the value of money should be tested, and the power of repeating simple forms of words in general use, such as the Lord's Prayer and Creed. In testing the power of attention, merely negative or affirmative answers to leading questions should be distinguished from such replies as indicate judgment and reflection. If the inquiry relate not to the capacity of the mind, but to its soundness in other respects, delusions should be sought for by conversations directed to those topics that are most likely to interest and excite the mind. The state of the moral feelings will be tested by conversation directed to relatives and friends. In cases of supposed

moral insanity, diligent inquiry should be made into the motives which might have led to the commission of the act of which the party is accused.

8. The medical man should insist on full opportunity being given him of forming his opinion. He should rarely content himself with a single visit; and in cases of great difficulty, should require that the party be placed for some time under his observation.

9. When undergoing examination in a court of law, the medical witness is recommended to avoid all definitions of insanity, on the plea that mental, like bodily diseases, do not admit of definition, but are subjects for description.

10. In signing certificates of lunacy, the medical man should bear in mind that he is required to see the patient by himself, to sign the certificate at the time of the visit, and to assign the reasons which have influenced him in attaching his signature to it.

To the foregoing directions a few practical suggestions and hints may be added with advantage relating to the two important and responsible duties of the medical man—imposing restraint, and signing certificates.

Restraint.—The medical man, in the exercise of his profession, may be called to a patient suffering from fever, delirium tremens, or mania, and may find him in a state of excitement dangerous to himself and to those about him. It seems as natural to him to order the patient to be restrained as to prescribe medicine for him. If he were not to order him to be placed under restraint, and the patient were to destroy himself or others, he would expose himself to the indignant censure of the whole community. But if, in the exercise of his discretion, he makes arrangements for restraining the patient, and the patient, on recovery, real or apparent, pleases to sue him for damages, he may inflict upon him the annoyance, loss of time, and expense of a trial by jury. This risk, it appears, cannot be avoided; but it may be reduced by the medical man observing the precaution of obtaining a written authority from the nearest relative in attendance on the patient—from husband or wife, father or mother, brother or sister, as the case may be.

Certificates.—In the case of paupers one medical certificate only is required, with an order signed by a justice of the peace, or, in his absence, by the relieving officer or overseer and the officiating clergyman of the parish in which the lunatic is at the time. In all other cases the certificates of two medical practitioners and the formal demand of a relation or friend. These certificates, to be valid, must be signed by legally qualified prac-

titioners having no interest, direct or indirect, in the patient, or in the establishment to which he is to be sent; they must bear the exact address of the patient, and the date of the examination and signature; the visit must be a separate visit (each medical man examining the patient separately); and the certificate must set forth distinctly the grounds of the opinion, under the distinct heads of facts observed by himself, and facts communicated by others (such others to be specified). The certificate is to be signed with name, address, and date. It remains valid only for seven days. If defective it may be amended.

A proper printed form in accordance with the statutes regulating the custody and treatment of the insane, and containing plain marginal directions, may be obtained of the law stationers.

In the case of insane persons wandering abroad, without proper care, provision is made for their protection by 16 & 17 Vict. secs. 67, 68, and 70: which inflict a fine of 10*l.* on medical officers of parishes, as well as on overseers or relieving officers, who, having knowledge, in any way obtained, that a lunatic is "wandering at large" or "not under proper care and control" or "cruelly treated or neglected" does not take measures to bring the case before a magistrate. Additional protection is afforded to the insane person, and to the public, by sec. 68 of this Act, which makes it "lawful for any justice, upon its being made to appear to him by the information upon oath of any person whomsoever that any person wandering at large within the limits of his jurisdiction is deemed to be a lunatic, by an order under the hand and seal of such justice, to require any constable of the parish or place, or relieving officer or overseer of the parish where such person may be found, to apprehend him and bring him before such justice," &c.*

* The reader will find much valuable information on the legal relations of insanity, and on the duties of medical men in charge of asylums, as well as on the whole subject of unsoundness of mind, in Dr. Sankey's 'Lectures on Mental Disease,' 1866. Those who are directly interested in the care and custody of the insane should consult 16 and 17 Vict. cap. 96 and 97, also 8 and 9 Vict. cap. 100.

PART II.

CHAPTER I.

PERSONS FOUND DEAD—REAL AND APPARENT DEATH—SUDDEN DEATH—SURVIVORSHIP.

UNDER the title of *Persons found Dead* the general precautions to be observed in conducting inquiries concerning persons whose mode of death is unknown, will be discussed. As the first question which would naturally be raised is as to the reality of death, the subject of *Real and Apparent Death* follows in order; then *Sudden Death*, in which some of the more common modes of dissolution are briefly considered; and, lastly, *Survivorship.*

PERSONS FOUND DEAD.

In treating of Medical Evidence, instructions were given as to the best mode of stating facts and opinions in a court of law, so as to give them their full force, and to render them admissible as evidence. In this place, directions will be given for observing and collecting that important class of facts which refers to persons found dead; in other words, for discharging, in reference to such persons, the functions of a common and of a skilled witness. If sent for to a dying man, or to one already dead, he must of necessity observe many things connected with the body itself, such as the position in which it is placed, and the objects by which it is surrounded, that might just as well be observed and stated in evidence by any other person; but a post-mortem inspection if required, must be entrusted to himself or to some other skilled member of the profession. Hence the present inquiry branches off into two divisions. 1. *The relation of the body to surrounding objects.* 2. *Directions for the performance of post-mortem inspections for legal purposes.*

I. RELATION OF THE BODY TO SURROUNDING OBJECTS.

The medical man is summoned to most cases of severe illness or sudden death, and thus becomes one of the first witnesses of those simple facts which, in criminal cases, constitute the presumptive or circumstantial evidence. He is also, in most cases, by far the best educated and most intelligent witness. Whenever, then, he is called to visit the dying or the dead under circumstances of suspicion, he should be alive to all that is passing around him, that no object, however trifling, calculated to throw light on the cause of death, may be overlooked. The following are some of the principal points to which his attention should be directed :—

The place in which the body is found.—This is not always that in which death actually took place; for, in suicidal as well as homicidal cases, persons severely wounded may be able to move some distance from the spot on which their injuries were received, and the murderer sometimes tries to conceal his crime by carrying the body to a place remote from the scene of violence.

The position and attitude of the body.—This does not always correspond with the cause of death. Thus the body of a man killed by a blow on the head was found standing upright, supported by a wooden fence. Murderers often so dispose of the bodies of their victims as to make it appear that they died by their own hands. Thus, persons who had been poisoned have been afterwards suspended by the neck, or thrown into the water; and the body of Sir Edmundbury Godfrey, who was proved to have been violently strangled, was found lying in a ditch, pierced with his own sword, and with his clothes so arranged as to create the belief that he had died by his own hand. From observations made on the field of battle, it may be inferred that those who are killed in a hand-to-hand struggle often wear an expression of rage, contrasting strongly with the calm expression of those killed by gunshot. Some soldiers, too, are found to maintain the very attitude in which they died. As many murders and homicides are preceded by a struggle, we should expect to find an expression of angry resistance on the face, hands, and body.

The spot on which the body is found.—It is often highly important to examine carefully the spot on which a body lies. In the case of fatal injury to the head, it is usual to allege that the death was caused by a fall on some hard resisting body; an allegation only to be rebutted by an examination of the spot. Thus, the death of a man found lying in a field with a severe bruise on

the head, having been attributed to a fall on a stone or fragment of wood, the field was carefully searched, and no such object could be found near the spot on which the body lay. In another case, a small wound of the head, which had penetrated to the brain, and had been received during a murderous struggle, was attributed to a fall on a sharp object, such as a nail fixed in the floor; but the floor having been examined, and no such object found, it followed that the wound had been inflicted by some small-pointed instrument. The murderer, after his acquittal, which was due to defective medical evidence, confessed that he had struck his victim with the point of a pair of snuffers.

The soil or surface on which the body lies.—It often happens that a struggle leaves on the spot traces which may be compared with the clothes of the suspected murderer or of his victim. Foot-prints in the snow, or on the soil, for instance, have often furnished important evidence. Sir Walter Scott gives an account of a murder discovered by the print of the murderer's foot left on the clay floor of a cottage in the death-struggle. The measure of the foot, the tread, and the mode in which the sole of one of the shoes had been patched, corresponded most closely with the foot-mark; and this was the first link in the chain of evidence which led to the conviction of the murderer. In cases of murder, followed by the suicide of the murderer, important light has been sometimes thrown on the transaction by finding stains of blood on the floor, and on the soles of the feet of the perpetrator of the double crime.

Position of surrounding objects.—In suicidal cases the instrument of death is generally found near the body: in homicidal cases it is often removed and concealed. In death by the more active poisons, the vessel which contained the poison is often found on, or close to, the person. The close correspondence of wounds or bruises found on a dead body, with the objects immediately surrounding it, sometimes throws great light on the cause of death. Thus, in the case of the Prince de Condé, who was found suspended by the neck in his bed-room, the correspondence of certain abrasions on the legs with a heavy chair placed close to them, and of others on the shoulder with a projecting part of the window to which he was suspended, harmonized with the struggles of a man suspended during life, and justified the opinion of those who attributed the death to suicide.

The Clothes.—Having noted the place and spot on which the body lies, its position, and the objects by which it is surrounded, a more close inspection should be made of the body itself. The clothes may be soiled with mud, or corroded by an acid, or stained

by blood, or some animal secretion; or they may be torn or cut. The character and position of the stains, and the direction of the rents or cuts, should be carefully noted; and cuts which traverse more garments than one should be compared with each other, and with wounds found on the body; for it may happen that a murderer tries to conceal his crime by cutting the clothes after he has wounded the body, and that the wounds and incisions do not coincide. It is scarcely necessary to state that criminals are being constantly identified through the close correspondence of things found in their possession with those used in the perpetration of the crimes themselves. The bearing and conduct of the parties in attendance on sick, dying, or dead persons should not be overlooked, especially in cases of suspected poisoning.

The foregoing are some of the points to be attended to in respect of persons found dead; but neither examples nor rules can do more than suggest the sort of inquiries that may be necessary. There must always be great scope for individual judgment, foresight, and decision. To the correctness of a good observer the medical witness must add the intelligence and invention of an acute experimenter. The service which an intelligent medical witness may have it in his power to render to the cause of justice cannot be better illustrated than by a case, for which the author is indebted to the late Dr. James Reid. It is given, as nearly as possible, in his own words:—"I was sent for one day to a man and his wife, whom I found lying in the same room with their throats cut. The woman lay on the floor, with her right arm extended under the bed, and a razor close to her right hand. Her throat was deeply cut from ear to ear, and she lay in a complete pool of blood. The husband, who was in bed, had a wound in the throat, which had merely divided the trachea without wounding any important blood-vessel, and without causing any great loss of blood. When questioned, he gave the following account:—In the middle of the night he was roused from sleep by receiving a wound in the throat from the hand of his wife. The shock, the wound, and the loss of blood together, had prevented him from making any resistance or giving any alarm. My suspicions were roused, partly by the man's manner, and partly by observing the water in a basin standing in the room slightly tinged with blood. In endeavouring to find some confirmation of my suspicions, a thought struck me. I turned up the bed-clothes, and found the soles of the feet covered with dried blood. I stated this fact to the jury at the coroner's inquest: a verdict of guilty was immediately returned, but the man died almost at the moment that the sentence was passed."

II. EXAMINATION OF THE BODY.—POST-MORTEM INSPECTION.

The medical man having discharged the duty of a common witness by noting all those points of presumptive or circumstantial evidence which may throw light on the mode and cause of death, proceeds to the examination of the body itself. When it is that of some person unknown, those characteristics which may lead to its identification should be noted down, in accordance with the instructions given at p. 8. Those appearances which serve to denote the time of the death (see p. 233) should next be observed, and then any external injuries which the body may have received.

If any wounds, bruises, or excoriations exist, their nature must be specified, and their extent determined by exact measurement. The neck, back, and limbs should be examined, in search of dislocations or fractures, the chest compressed, to ascertain whether blood, or any fluid mixed with air or gas, escapes from the mouth or nostrils; the cavity of the mouth inspected, in search of foreign bodies, or stains of corrosive poisons; and the anus for poisons introduced into the body by that opening. In new-born children the orbits, fontanelles, and nuchæ should be inspected, in search of minute wounds inflicted by pointed instruments. In women, the point of junction of the breasts (especially on the left side), with the skin of the chest, should be examined, in search of minute wounds. The female organs of generation should also be examined in search of poisons, corrosive acids, or wounds.

Post-Mortem Inspection.—The great rule to be observed in conducting post-mortem inspections for medico-legal purposes, is to examine every cavity and important organ of the body. Even when the cause of death is quite obvious, it is well to observe this caution, for if any part of the body have been left unexamined, the objection may be made that the cause of death might have been found there, or some disease which would have given a mortal character to an injury not otherwise fatal. The order in which the cavities are examined must depend, in part, on the supposed cause of death. As a general rule, the seat of injury should be inspected first, before the contents of the blood-vessels have been disturbed by the examination of other parts. It must be quite unnecessary to insist on the duty of conducting every step of the examination with great care and circumspection. Specific directions for post-mortem examinations in cases of rape, delivery, poisoning, infanticide, &c., are given under those heads.

REAL AND APPARENT DEATH.

This subject has never attracted much attention in England, and no medical author of repute has treated it at any length. In earlier periods of our history persons ran some risk of being buried alive, but this risk has now disappeared, and is not likely to recur unless in the improbable event of some fatal epidemic rendering speedy interment expedient. But the question of real or apparent death may assume practical importance long before the usual period of interment arrives. In cases of suspended animation, the adoption, neglect, or speedy abandonment of measures for restoring life, must depend on the previous answer to the question—Is life really extinct?

On the Continent, and especially in France, this subject of real and apparent death is treated with greater respect, has employed the pens of such distinguished medico-legal writers as Winslow, Bruhier, and Louis, and has received some attention at the hands of Mahon, Foderé, and Orfila. The importance thus attached to the subject abroad is accounted for by the practice of early interment, and by the Roman Catholic rite of extreme unction, which raises a serious impediment to the use of means for restoring animation.

There are three forms of suspended animation which may be mistaken for real death—*syncope, asphyxia,* and *trance.*

1. *Syncope.*—There is good reason to believe that, in the majority of instances, the apparent death, about which so much has been said and written, was merely a prolonged faint. The success attending the accidental employment of the very means which are most efficacious in restoring those who have fainted, namely, cold water and fresh air, seems to prove this. The efficacy of cold water is attested by Hippocrates in the case of a woman apparently dead from fever, and by John Howard, who bears his personal testimony to the restoration of supposed victims of gaol fever, brought out for burial, on being washed with cold water!

The efficacy of pure cold air rests on the authority of Diemerbröck and Zacchias in cases of plague; and well authenticated instances of similar recovery after small-pox are on record. One of these occurred in the person of an infant daughter of Henry Laurens, the first President of the American Congress. She had small-pox, and was laid out as dead; but the window of the apartment that had been carefully closed during the illness, being thrown open, the fresh air revived her. Such cases were not of rare occurrence before the time of Sydenham, who abolished

the stifling system of treating eruptive diseases, especially small-pox.

The acknowledged existence of cases of prolonged syncope after febrile and eruptive diseases gives probability to cases in which recovery from a state of apparent death is alleged to have occurred at the touch of the scalpel, or in ancient times under the flame of the funeral pyre.

2. *Asphyxia.*—This is a form of suspended animation of very frequent occurrence. It is being continually mistaken for real death, and can be distinguished from it only by the result of the means employed for the recovery of the patient.

3. *Trance.*—Cases of suspended animation, not answering exactly to the description of syncope or asphyxia occasionally occur in females. The motionless and insensible state of the frame, the coldness of the surface, and the apparent suspension of the functions of respiration and circulation, combine to produce a semblance of death, and to create temporary difficulty even for the medical man.

The subject of real and apparent death would be incomplete if some notice were not taken of those cases in which a state of apparent death has been brought about by an effort of the will. The occasional occurrence of such cases has been placed beyond the reach of doubt; and a minutely described and well authenticated instance of this kind, that of the Honourable Colonel Townshend, is related by Cheyne in his 'English Malady.'

"He told us he had sent for us to give him some account of an odd sensation he had for some time observed and felt in himself; which was that composing himself, he could die or expire when he pleased, and yet, by an effort, or somehow, he could come to life again, which, it seems, he had sometimes tried before he had sent for us. We all three felt his pulse first: it was distinct, though small and thready, and his heart had its usual beating. He composed himself on his back, and lay in a still posture some time; while I held his right hand, Dr. Baynard laid his hand on his heart, and Mr. Skrine held a clean looking-glass to his mouth. I found his pulse sink gradually, till at last I could not feel any by the most exact and nice touch. Dr. Baynard could not feel the least motion in his heart, nor Mr. Skrine discern the least soil of breath on the bright mirror he held to his mouth. Then each of us by turns examined his arm, heart, and breath, but could not by the nicest scrutiny discover the least symptom of life in him. This continued about half an hour. As we were going away (thinking him dead), we observed some motion about the body, and upon examination found his pulse and the motion of

his heart gradually returning; he began to breathe gently, and speak softly." This experiment was made in the morning, and he died in the evening. On opening the body nothing was discovered but disease of the kidney, for which he had long been under medical treatment, all the other viscera being perfectly sound.

This case of Colonel Townshend is not only curious but instructive, as it renders it in the highest degree probable, that there may be states of system so nearly resembling death as even to deceive medical men, and distinguishable from real death only by the continuance of animal heat and the absence of rigidity, and by the success of the means of restoration.

The fact that there are certain states of the living system which may for considerable periods closely simulate death, admits of important practical application. It teaches us that we should not hastily abandon the attempt to resuscitate persons who have appeared to perish by syncope or asphyxia, by hæmorrhage, shock, sun-stroke, drowning, and the several forms of suffocation.

Signs of Death.—Of the signs of death insisted upon by authors some are trivial and inconclusive, others of considerable importance, both as signs and as means of forming a judgment of the time that life has been extinct. To the first class belong the *Cessation of the Circulation and Respiration; the Absence of Sense and Motion; the Facies Hippocratica; the State of the Eye; the State of the Skin;* and *the Extinction of Muscular Irritability.* To the latter class belong the *Extinction of Animal Heat; Cadaveric Rigidity;* and *Putrefaction.*

Cessation of the Circulation.—If no pulse can be felt at the wrist, and the beat of the heart can neither be felt nor heard, it may be assumed that the circulation of the blood has ceased, though it is possible that very feeble movements of the heart might escape observation. But whether the heart cease to beat altogether, or contract so feebly as to be imperceptible to the hand or ear, is of little consequence, as the fact of life having been restored after its contractions had been apparently suspended for a time, as in the case of Colonel Townshend, is enough to deprive the test of all practical value.

Cessation of the Respiration.—The functions of circulation and respiration are so connected, that what is true of the one is likely to be true of the other. The tests of respiration —the looking-glass, and feather held to the mouth, and the cup of water placed on the chest or abdomen—are at least as delicate as those by which we seek to determine the continuance of the heart's action. It is scarcely possible that respiration should take place in any degree, and yet escape detection by such means; and yet in the case of

Colonel Townshend, the glass remained for a long period unsoiled, and no trace of respiration could be detected. The suspension of the respiration, therefore, like the cessation of the circulation, is not to be regarded as a sure sign of death.

The same remarks apply to the joint cessation of the respiration and circulation as to the cessation of either separately.

Absence of Sense and Motion.—Insensibility and immobility are common to suspended animation and real death; and they are therefore uncertain signs. The combination is not rare in hysteric females, and in the mesmeric slumber; but in these cases the functions of circulation and respiration go on uninterruptedly, and a careful observer will sometimes detect a vibrating movement of the eyelid, which forms an exception to the general rule of immobility.

The Facies Hippocratica.—This peculiar expression of countenance, combining the sunken eye, the sharp nose, the pointed chin, the hollow temple, the prominent cheek-bone, the projecting ear, the wrinkled brow, the dry livid skin, and the white powdered hair of the nostrils and eyebrows, is a trivial and unsafe sign of death, open to the serious objections :—1. That it is nearly always absent in cases of sudden death, and in the victims of acute disease. 2. That it is present in the dying as well as in the dead, and has been observed where recovery has taken place. 3. That it may be brought about by a strong impression of danger, the apprehension of a dreadful punishment, or the anticipation of certain death. And 4. That where it exists, it does not long survive the extinction of life.

State of the Eye.—A tenacious glairy mucus on the conjunctiva, causing a loss of transparency in the eye, and a collapsed and wrinkled state of the cornea, are among the best and earliest of the trivial signs of death. But they are not conclusive; for, on the one hand, the conjunctiva may be invested by a mucous film and the cornea may lose its brilliancy in the living, and, on the other hand, in death from *apoplexy, carbonic acid,* and *prussic acid,* the eyes may preserve their brilliancy and prominence for a long time. Putrefaction, too, or a ferment introduced into the stomach, by distending the body with gas, sends blood to the head, and makes the eyes brilliant and prominent. (Nysten.)

State of the Skin.—*Pallor* of the skin, owing to absence of circulation; *livid discolorations,* the result of the subsidence of the blood; and *loss of elasticity,* have been mentioned among the signs of death. Pallor may exist during life, and be absent in several forms of death, especially in death from suffocation.

Livid discolorations, too, may exist in aged and feeble persons in depending parts of the body. But loss of elasticity is a sign of considerable value and very early developed.

Extinction of Muscular Irritability was recommended by Nysten as a certain sign of death. He proposed to lay bare a muscle and test it by puncture or by the galvanic fluid. The absence of contraction was justly assumed to be a sign of death, but its presence could only be taken to prove that the body was either alive or recently dead.

Among the trivial signs of death, the flexure of the thumb across the palm of the hand may be mentioned. The thumb assumes this position before cadaveric rigidity comes on, but it is similarly contracted during life in certain spasmodic affections.

The foregoing signs do not supply the means of determining how long life has been extinct. But the extinction of animal heat, rigidity, and putrefaction, being both certain signs of death, and means of determining, with more or less precision and certainty, the time at which death took place, should be examined more closely.

SIGNS OF DEATH WHICH ARE ALSO MEANS OF DETERMINING HOW LONG LIFE HAS BEEN EXTINCT.

Extinction of Animal Heat.—The temperature of the body is closely dependent on the circulation of the blood; so that when this ceases, in a part of the body or in the entire frame, that part, or the whole body, soon becomes cold. Hence the extremities grow cold before death; and as the circulation becomes more and more languid, even the internal parts cool down, as is shown by the low temperature of the breath; and at length, when life is extinct, every part of the body becomes cold. But as, on the one hand, great coldness of the body is often present during life, and in cases of suspended animation, and, on the other hand, in cases of sudden and violent death the body often parts with its heat very slowly, the value of this sign of death is impaired. An anomalous restoration of heat to the body, without any other sign of life, has also been observed to take place after death by cholera, and Mr. Savory has shown that in a rabbit and dog killed by strychnia, the temperature rose one or two degrees after life was extinct.

Nor is the extinction of animal heat a very sure means of determining the time of death; for the rate of cooling of the body varies with the age, the cause of death, the treatment of the body itself, and the state of the atmosphere; so that the period

of cooling may vary from two or three hours to fifteen or twenty, and may even extend to upwards of four days.

The body cools slowly when clothed and exposed to a warm, still atmosphere, quickly when exposed naked to a draft of cold air. It parts with its heat more speedily in water than in air. Age, emaciation, and death by hæmorrhage or chronic disease favour the cooling of the body; youth and vigour, corpulence, and acute disease or speedy death retard it. In persons falling victims to the same disease, the extinction of animal heat is, *cæteris paribus*, as the rapidity with which it proves fatal. In chronic diseases, the body parts with much of its heat during life.

Some important medico-legal cases which have lately occurred (Cases of Hopley, 1860, Doidge, Gardner the Sweep, and Jesse M'Pherson, 1862), have shown the necessity of examining this subject more closely, with a view, if possible, of determining the rate of cooling of the dead body, and the time at which death took place. Accordingly Drs. Taylor and Wilks have recorded a series of observations on bodies transferred from the wards of the hospital to the dead-house; out of 100 observations so made, 70 are available for a philosophical inquiry, and the facts, when submitted to careful examination and analysis, are found to yield some instructive results. The bodies when removed from the wards to the dead-house, were placed in an open shell, and covered only with a shirt, shift, or sheet; and from the time of deposit in the dead-house the temperature of the skin of the abdomen was ascertained at various successive intervals, by the thermometer. 70 complete observations, recording the temperature of the wards and dead-house, as well as of the body, and extending over the period from February to June, 1863, gave for the wards a range from 50° to 68° Fahr., and for the dead-house from 38° to 59°. Though several of the observations extended to from 16 to 20 hours, the body, in no case, fell to the temperature of the air, the nearest approach to it being in the case of a girl æt. 19, who died of phthisis, and in whom 16 hours after death the temperature of the body had fallen to 52°, that of the dead-house being 48°. It is clear, then, that the cooling of the body, even when covered only by a single layer of cotton or linen, is a very slow process, and that in the case of a body clothed, or in bed, and in a room of moderate temperature, it would be unreasonable to expect the cooling of the body till the lapse of upwards of 24 hours at the very least. It ought also to be understood that the temperature of the body, when first ascertained two hours after death, in 18 instances presented a

maximum of 88°, a minimum of 76°, and a mean of 83°; also that on an average the rate of cooling is about one degree per hour. If then, in any case, we assume the temperature of the abdomen at death to have been 90°, and the temperature of the air 60°, it would not be reasonable to expect the temperature of the abdomen to have fallen to that of the air till the lapse of at least 30 hours. These statements are the result of an analysis which we have made of the facts contained in the tables.* But these facts and inferences must be applied to individual cases with great caution; for not only have we every variety of cause of death (both disease and accident), but an unusual exposure of the body; and a rate of cooling, which though on an average about a degree an hour, was in some cases as low as $\frac{1}{2}$°, and in others as high as 2°, 3°, or even 4°.

By extracting from the tables the cases of death by accident, eight in number, assuming the rate of cooling from the period of death to the date of the first observation to have been equal to that subsequently ascertained, and disregarding the ascertained temperature of the dead-house, I have obtained the following figures as applicable to death by violence, followed by free exposure of the body to the air with a single light covering:—average temperature of abdomen at death, 83°; range of temperature of abdomen at death, 79°—89°; rate of cooling per hour, about 1°, or approximatively 13° in 11 hours. These are the most precise data we now possess applicable to cases of violent death; and we cannot approximate nearer to the truth than by assuming a temperature at death of 83°, and a rate of cooling per hour of more than one degree if the body is exposed, or less than one degree if it is clothed.

The use of the thermometer may be very properly insisted on in every case, as much more satisfactory than the sensations of the observer: and it is not to be doubted that very incorrect inferences may be drawn from the sensation of cold as imparted to the hand of an observer on touching the hands or feet, the nose or ears, of a corpse recently dead. A man must have little experience of living bodies who does not know what a sensation of icy coldness may be imparted to the warm hand by contact with the hands or feet of another.

Cadaveric Rigidity—Rigor mortis.—For some time after life is apparently extinct, the muscles continue to contract when stimulated. The extreme duration of this irritability, even in the muscles of voluntary motion, does not exceed two hours;

* 'On the Cooling of the Human Body after Death.' By Dr. Alfred S. Taylor and Dr. Wilks: 'Guy's Hospital Reports,' Oct. 1863, p. 184.

and when it ceases, cadaveric rigidity sets in. The experiments of Vulpian and Brown-Séquard show that this irritability of the muscles lasts longer in a low temperature than in a higher one; and the last-named author proved by experiment that both the contractility of the muscles might be restored, and the rigidity of the corpse be destroyed for a time by injecting defibrinated arterial blood, or aerated venous blood, into the vessels;* also that the rigor mortis may be hastened by exhausting the irritability of the muscles by powerful and repeated galvanic shocks.

This phenomenon occurs in all classes of animals alike, and is the first certain evidence of death. It makes its appearance long before the body has cooled, and commences in those parts that lose their heat the latest. It may even set in before the heart has ceased to beat. On the other hand, it may be delayed twenty-four hours or more; and it may last for a few minutes or for several days, or even as long as two or three weeks. Its seat is in the muscles, and so long as they remain entire, the limbs continue inflexible, unless great force be used; but when they are cut or torn, the rigidity ceases. It takes place in all positions of the trunk and limbs, without changing those positions. It shows itself successively in the muscles of the back, of the head and lower jaw, in those of the face, in those of the neck and chest, in the arms, in the legs: and it disappears nearly in the same order; the muscles of the lower extremity often remaining rigid when those of the trunk and upper extremity have resumed their state of relaxation. It is entirely independent of the nervous system, for it comes on after the nerves have ceased to be excited by the galvanic fluid. A division of the nerves, even the removal of the brain, does not prevent its occurrence; and in death from apoplexy or hemiplegia, the paralysed limb is affected in the same way, and to the same extent, as the sound one. It is strongly marked and persistent in muscular subjects, and, as a general rule, it lasts long when it sets in late. In death by lingering diseases, such as low fever, consumption, and scurvy, and the diseases of old age, the rigidity sets in very speedily, and disappears again in the course of one or two hours. It also sets in very soon in animals over-driven or hunted to death, in soldiers killed late in a battle, and in persons exhausted by convulsions (Savory). On the other hand, in death by acute inflammation of the stomach or viscera, by irritant poisons, whether mineral, vegetable, or aërial (provided they exert no specific influence on the contractile powers of the muscles), the

* See Savory's fourth lecture on 'Life and Death' for several facts cited in this chapter.

rigidity is for the most part slow in making its appearance, strongly developed, and lasts for a considerable time. After death from cholera rigidity is said to commence very early, and to last four or five days. It is slow in showing itself in death from apoplexy, hæmorrhage, wounds of the heart, decapitation, injury of the spinal marrow, and asphyxia. Its duration in poisoning by carbonic acid is very considerable, and in one case Nysten found that it continued seven days. On the other hand, in poisoning by sulphuretted hydrogen, rigidity does not occur; and Casper alleges that it either does not take place after narcotic poisoning, or lasts a very short time. It is slightly developed, and of short continuance, in the new-born infant. A low temperature, and recent indulgence in spirits, are mentioned by Casper as favourable to the persistence of cadaveric rigidity; and in those cases where it lasts longest he has found it to co-exist with putrefactive changes.—(Handbook, vol. i. p. 30).

Cadaveric rigidity cannot be mistaken for the stiffness caused by intense cold, nor for any other condition of the dead body.

The rigidity of the muscular system present during life in such diseases as catalepsy and tetanus, is readily distinguished from cadaveric rigidity by forcibly bending the limb: if due to a vital contraction, it is restored to its position, which does not happen in the rigidity of death.

Rigidity, then, is a certain sign of death, and not to be confounded with any state of the living body, and as it supervenes after the extinction of muscular irritability, it is a sure indication of the hopelessness of attempts at resuscitation.

Putrefaction.—This, too, is an infallible sign of death, not requiring to be distinguished from any condition of the living body.

As the march of the putrefactive process affords some means of fixing the time of death, it will be necessary to describe the changes which it occasions in the body with some degree of minuteness.

In the interval that elapses between the extinction of life and the commencement of putrefaction, the body falls more and more under the influence of physical laws. The skin loses its elasticity, and the flesh its firmness, and the blood, which was equally distributed through the body, now gravitates towards the most depending parts. Hence the paleness of some parts and the deep violet tint of others, the discoloration of the occiput and back, and of the lowest lying parts of the intestines, lungs, and brain. The seat of the lividity is determined by the posture of the body, so that if it be placed on the face, it will occupy the anterior part of the body and of the viscera. If again, after discolorations

have formed on the back, the body be turned while still warm, and before the blood has coagulated, they will disappear. These discolorations are often very extensive, and when the body lies on a smooth surface, uniform in tint; but if the surface is uneven, the discolorations are interrupted and irregular. The pressure of the clothes produces the same effect; so that a careless observer might mistake the marks of clothes fastened round the neck for the effect of strangulation, or isolated patches for severe bruises.

The extent and amount of discoloration are proportioned to the quantity of the blood, so that its prevalence through the whole body indicates a general fulness of the vascular system, and *vice versâ*. Sudden death, unattended by loss of blood, is characterized by extensive lividity; but after death preceded or caused by hæmorrhage, the skin presents but faint traces of such discoloration.

This subsidence of the blood explains the diminished intensity of colour in parts which had been the seat of the less severe and more diffuse forms of inflammation. But the appearance produced by such acute inflammation as follows burns and scalds, blisters, and strong friction, and the action of the more violent irritant poisons on the internal parts, are permanent, and quite distinct in the dead body.

Cadaveric lividity is said to be distinguished from the effect of injuries inflicted during life by the seat of the discoloration being the rete mucosum and vascular membrane exterior to the true skin. The vessels of these parts are filled with dark blood, so that the cut surface presents a black line from which the blood may be expelled by pressure. The dermis or true skin is white. But in the discolorations of the skin produced by the afflux of blood *during life* the tissue of the true skin is injected, and exhibits when divided a number of bloody points. This discoloration of the tissues external to the true skin, is, however, not invariable, for on comparing a vertical section of the integument from a part of the back deeply discoloured by cadaveric lividity, with a similar section from a highly inflamed portion of skin, the first was found to be quite free from vascular injection, while the last presented a number of red spots of extravasated blood. The two sections were mounted side by side, treated in every way the same, and examined by the same power of the microscope.

In connection with this subject of the subsidence of the blood, it will be necessary to notice the coagulation and consequent separation of the constituents of the blood which takes place after

death. This subject has been ably treated by Mr. Paget, in a paper published many years since.* He there shows that the blood contained in any cavity or vessel of the body at the time of death, coagulates as it would do if drawn into a basin, or other vessel, during life; that the part of the blood which occupies the highest position in the body, like the buffy coat of inflammation in blood drawn during life, is least coloured, and that which lies lowest the most; that such highest portion may be like a nearly colourless jelly, while the lowest has a deep blue or black colour; that this post-mortem separation is distinguishable from similar separations during life, inasmuch as the latter adhere in layers (as in the sac of an aneurism) to the containing cavity or vessel; and lastly, that, in most cases, the blood does not coagulate in the body till the lapse of from four to six, eight, or more hours, but yet coagulates within a few minutes of being let out of the vessels. Mr. Paget further shows that these phenomena of post-mortem coagulation may have a practical application in determining the posture in which the body was left for some time after death; and he gives in illustration the case of a man suffering from excessive dyspnœa, who died sitting up with his head resting on his knees, and so remained for three or four hours after death. The relative position of the constituents of the coagula, the exact reverse of that usually observed, justified the opinion expressed before the facts of the case were known to Mr. Paget, that the body had not been laid out in the usual manner.

Besides these discolorations caused by the blood which follows the course of the vessels, there are others due to transudation. Thus the parts in contact with the gall-bladder are deeply tinged with bile; and the eye shrinks from the transudation of the aqueous humour.

The subsidence of the blood and transudation of the fluids partly explain that relaxed and softened state of the tissues which is the first of the changes attributed to putrefaction. These fluids next undergo changes of colour, and tinge the several textures with brown, blue, or green discolorations, according to the degree of decomposition they have undergone. The discoloration of the corpse first shows itself on the abdomen, which assumes a greenish tint; this deepens and extends to the genitals; then irregular green patches appear on other parts of the body, which coalesce and change to a reddish-green, and at length occupy the whole surface with extensive bright green and red-brown patches.

Then follows the development of gases in the several cavities of

* On the Coagulation of the Blood after Death: 'London Medical Gazette,' vol. xxvii. p. 613.

the body, especially in the abdomen, which swells to a huge size. This formation of gas is sometimes so rapid and so extensive as to change the position of the body, and to displace the viscera and their contents. The diaphragm is thrust upward, the blood in the large vessels is forced toward the head and neck, the face swells, the eyes become prominent, and a mucous fluid or bloody froth flows from the mouth and nostrils. Sometimes the contents of the bowels are forced out. Blood also exudes from wounded or ruptured vessels, causing post-mortem hæmorrhages and extravasations. Of old, much importance was attached to this post-mortem bleeding of wounds, and if it happened to coincide with the touch of the criminal supposed to have inflicted them, he was summarily convicted. The loose tissues of the penis and scrotum are also largely distended. The nails and the hair are easily detached.

The development of gas (probably carbonic acid) in parts of the body filled with blood often seems to precede the other common signs of putrefaction. We have seen this early formation of gas both in the lungs and beneath the membranes of the brain. (See Infanticide, p. 93.)

As putrefaction advances, the cuticle becomes detached, the muscles grow viscid and pulpy, assume a dark-greenish colour, and exhale a highly offensive odour; and at length the whole body becomes changed into a soft semi-fluid mass, which gradually parts with its moisture, dries up, and leaves a fibrous fatty residue, slowly lost in the soil.

In some bodies these processes of putrefaction and decay go on very rapidly, and are soon completed; in others they are extended over a number of years, varying with the circumstances in which the body is placed. When the putrefactive process is once established under favourable circumstances it goes on rapidly, the parts already decomposed acting as a sort of leaven to the rest.

The conditions which affect the progress of putrefaction, and enable us to form an opinion as to the time at which death took place, are *Temperature, Moisture, and Access of air; Period, Place, and Mode of Interment; Age, Sex, Condition of Body, and Cause of Death.*

Temperature.—Putrefaction is arrested by a temperature of 212° and of 32°: in the former case the body is dried by evaporation; in the latter the fluids are congealed. The most favourable temperature is one ranging from 70° to 100°. Putrefaction, therefore, takes place more rapidly in summer than in winter, and, other things being equal, varies with the temperature.

Moisture.—This is an essential condition, without which putre-

faction cannot begin, or, having begun, cannot continue. The body contains, in all its parts, moisture enough to insure decomposition; but those parts, such as the brain and eye, which contain the largest quantity of fluid are most prone to putrefaction, and dropsical subjects putrefy speedily.

Putrefaction also commences soon, and runs a rapid course, in inflamed parts, in bruises, and at the edges of wounds.

Bodies which have remained for some time in the water, and are then exposed to the air, putrefy more rapidly than those which have not been immersed; but in bodies which remain in the water putrefaction goes on slowly, from the contact of air (another condition highly favourable to putrefaction) being prevented.

On the other hand, dryness of the air retards or arrests putrefaction. Hence the preservation of the bodies of travellers on sandy deserts.

A rapid current of air has the same effect by promoting evaporation. On the other hand, a moist and stagnant atmosphere encourages putrefaction, by retarding evaporation no less than by supplying moisture.

Access of Air.—That the presence of atmospheric air promotes putrefaction is shown by the slow development of gas that takes place when blood or flesh is introduced into a vessel through mercury, so as to exclude all the air which does not attach to the substance introduced: also, on the other hand, by the preservation of flesh in atmospheres not containing oxygen, such as hydrogen and nitrogen; less completely in atmospheres in which oxygen is chemically combined with some other gas, as in carbonic acid and nitrous acid; also in atmospheres filled with vapours that absorb oxygen, such as turpentine. Oxygen, when taken separately, promotes putrefaction more than any other gas, but when combined with nitrogen, as in the atmosphere, its activity is greatly increased.

Heat, moisture, and the free access of air, then, are the conditions most favourable to putrefaction; and in judging of the time at which death took place, we should consider well what amount of influence each of these agents has brought to bear on the result.

Period, Place, and Mode of Interment.—*Period.*—Bodies putrefy much more speedily in air than in the ground. Hence the longer interment is delayed, the greater the changes produced by putrefaction. Thus, Orfila observes, that if, during the summer, a body be exposed for five or six days, and then interred, it will be found, at the end of a month, to have undergone as

much change as it would have done at the end of seven months, if it had been interred at once.

Site.—In dry elevated situations, putrefaction goes on slowly; in low swampy grounds, rapidly. *Soil.*—A dry absorbent soil retards, a moist one accelerates, putrefaction. In sand or gravel the change goes on slowly, and adipocere is rarely met with: in marl or clay, and in loose mould, especially that which is impregnated with animal or vegetable matter, more quickly (except peat, which retards putrefaction). The deeper the grave, *cæteris paribus*, and the more completely the body is defended from the air by clothes or coffin, the slower the putrefaction. It is rapid where the body is in contact with the soil, but very slow where it is buried in a coffin hermetically sealed.*

Age.—Other things being equal, the bodies of children putrefy more speedily than those of adults and aged persons, and the bodies of old persons more rapidly than those of adults.

Sex.—According to Orfila, putrefaction takes place more rapidly in women than in men. He attributes this to the greater quantity of adipose matter with which their cellular membrane is loaded; an explanation, which, though not quite satisfactory, agrees with the fact that the corpulent undergo this change more readily than the lean and emaciated. Casper, who disputes the influence of sex, observes that the bodies of women dying during, or soon after, child-birth putrefy very rapidly.

Condition of Body and Cause of Death.—Putrefaction takes place most speedily in bodies filled with fluid. Accordingly, it is very rapid after sudden death, and death from acute disease (*e.g.* 15 hours in a woman dying from hydrophobia in mid-winter—Sauvage); slower after death from hæmorrhage, and from chronic disease, unless complicated with dropsy, or extensive structural change, as in typhus, and typhoid fevers, small-pox, erysipelas, &c.

The same observation applies to parts of the body as to the entire frame; for those parts which are full of fluid at the time of death, through inflammation, congestion, or dropsy, or in consequence of wounds or bruises, putrefy more rapidly than healthy and entire structures. In some instances, as in low fevers, putrefaction has attacked the extremities before the trunk of the body has ceased to live.

It was formerly believed that the bodies of persons destroyed by poison putrefied very rapidly; but this is now known to be a

* Consult Orfila's 'Traité des Exhumations Juridiques,' and Devergie's 'Médecine Légale,' which contains the marrow of Orfila's observations, with his own account of the changes produced by putrefaction in the water. See also Casper's Handbook, vol. i. p. 30.

mistake. Casper specifies phosphorus, alcohol, and sulphuric acid, as poisons that decidedly retard putrefaction, and though he classes smoke and carbonic acid with sulphuretted hydrogen and narcotic poisons, as hastening the putrefactive process, it appears from three cases reported by Devergie, that in death by inhaling carbonic acid, the process is decidedly retarded. Arsenic, and the other mineral poisons, act as antiseptics. Animal and vegetable poisons have probably no effect either way; but persons killed by them putrefy rapidly, as in other cases of speedy death. There is reason to believe that putrefaction takes place with unusual rapidity in animals driven soon after a meal and dying suddenly; as well as in men dying suddenly during violent exertion.

Putrefaction in Water.—More dependence is to be placed on the criteria laid down for determining the period of death of bodies which have remained in the water, than of those exposed to the air or interred, for the obvious reasons, that the temperature of the water is more uniform, and the body, unless when it rises to the surface, is protected from the air. As Devergie, whose official position at the Paris Morgue has given him unusual means of observation, places much reliance on the signs by which the period of death is determined in the drowned, the following account based upon his description is subjoined:—

The bodies of the drowned are subject, like those who perish in other ways, to loss of heat and rigidity, and to putrefaction, but in a modified form, accompanied by the formation of adipocere. One of the first changes, which may be seen as early as the *third or fourth day*, consists in bleaching of the skin of the hands. *At the end of a week* the body is found supple, and the skin of the palms of the hands very white. *A week to twelve days* of immersion bleaches the backs of the hands, and softens and bleaches the face. *At the end of a fortnight* the hands and feet are bleached and wrinkled, the face slightly swollen with spots of red, and the middle of the sternum has a greenish tint. *At the end of a month*, the hands and feet are completely bleached and wrinkled as if by a poultice, the eyelids and lips are green, the rest of the face reddish-brown, and the front of the chest presents a large patch of green with a reddish brown spot in the centre. *At the end of two months*, the face is swollen brown, and the hairs are but slightly adherent: much of the skin of the hands and feet is detached, but the nails have not separated. *At two months and a half*, the skin and nails of the hands are detached, and the skin of the feet, but the toe-nails are still adherent. In the female, reddish discoloration of the subcutaneous cellular

tissue of the neck, of that which surrounds the trachea, and of the organs contained in the cavity of the chest; partial saponification of the cheeks and chin; superficial saponification of the mammæ, the axillæ, and the anterior part of the thighs. *At three months and a half*, the skin and nails of the hands and feet completely removed; part of the hairy scalp, of the eyelids, and of the nose, and the skin of many parts of the body destroyed; and the face and upper part of the neck and axillæ partially saponified. *At four months and a half*, nearly total saponification of the fat of the face, of the neck, of the axillæ, and of the anterior part of the thighs; commencing earthy incrustation of the thighs; incipient saponification of the anterior part of the brain; opaline state of the greater part of the skin; almost entire separation and destruction of the hairy scalp; calvarium denuded and beginning to be very friable.

As to the more remote periods no accurate approximations can be given; but Devergie alleges that the above signs have been repeatedly applied with complete success to bodies that have remained in the water for periods unknown at the time of their examination.

The foregoing description applies to bodies immersed during winter. Bodies immersed in summer undergo the same changes much more rapidly. Thus, 5 to 8 hours in summer correspond to 3 to 5 days in winter; 24 hours to 4 to 8 days; 48 hours to 8 to 12 days; 4 days to 15 days. Thus on the average the same changes in summer take place from three to five or six times as rapidly as in winter, or even more promptly than that, the changes in spring and autumn being intermediate.

This account would be incomplete without some further notice of that development of gas within the body which causes it to rise to the surface. This takes place slowly in winter, and the body rarely rises to the surface in less than six weeks or two months. But the same change takes place in summer from the 14th to the 16th day, or even earlier. In some instances the body is found to float at a much earlier period than either of those now indicated.

Frequent mention has been made of *adipocere*. This derives its name from the resemblance it bears to a compound of wax and fat. It is a sort of animal soap, formed by the union of the margaric and oleic acids, arising from the decomposition of the fat with the ammonia generated during decomposition.

Adipocere is formed in bodies which remain long in water, also in bodies buried in moist soils, and especially where a large number have been interred in one common grave. That it may be

completely transformed, a body must remain about three years in the ground and about one year in water, the change commencing as early as the third or fourth week.

Adipocere is sometimes of a pure white colour, sometimes of a yellowish or brownish white; soft to the touch, or when cut; melting when heated; and having a faint and not disagreeable odour. Bodies wholly converted into this substance have a ghastly bleached appearance, but retain their form, so as to admit of identification. In appearance they contrast very strongly with bodies that have undergone "mummification" by the rapid dissipation or absorption of their moisture, by protection from the air, or by the injection of preservative fluids. In such bodies the soft parts, greatly reduced in bulk, assume a rusty-brown colour, and show traces of their original texture. The skin is sometimes preserved as a parchment-like covering, the softer parts having been removed by insects. In the course of a very extensive disinterment, we had opportunities of seeing many bodies that had undergone these three changes.

Of the subject of putrefaction generally, it should be observed that it is, from the nature of things, surrounded with difficulties. When we desire to fix the period of the death by the changes which the body has undergone, we are made sensible of the many elements which must have combined to produce special changes in the body. So that we are prepared to read without surprise the following statements:—"On the 20th March, 1848, I examined the bodies of fourteen men, almost all of the *same age*, 24–30 years, previously occupying precisely the *same social position* (workmen of the lowest class), all lying together in the *same* part of our dead-house, who had all met the *same* death, having been shot on the barricades on the 18th of March, and had all notoriously died at the *same* time." "And yet I can testify that in no one case did the signs of putrefaction resemble those of another." (Casper's Handbook, vol. i. p. 33.) "An old couple of about the same age, 50–60 years, were suffocated during the night by carbonic acid gas. Up to the time of our examination, these bodies had been exposed to precisely similar influences, and yet (on the fourth day after death, in November) the body of the man was quite green both on the abdomen and the back, and the trachea was brownish-red from putridity, &c., while his uncommonly fat wife was perfectly fresh both outside and in." (Ibid. p. 34.) In the face of facts like these, we find both French and German authors speaking with much confidence of the value of the signs of putrefaction. Thus Casper himself states that at a tolerably similar average temperature putrefac-

tion in the open air, in water, and in a coffin, will have advanced equally after the lapse of one, two, and eight months respectively.

SUDDEN DEATH.

That cases of sudden or speedy death are not uncommon may be inferred from the fact that from 3500 to 4000 sudden deaths occur year by year in England and Wales from causes not ascertained, over and above the 15,000 returned as due to violent causes, of which the greater number also belong to this class. Though it may not always be possible to ascertain the true cause of death, some advantage may arise from a discussion of some of the common causes of sudden and speedy death, coupled with some account of those appearances in the body which are most characteristic of different modes of dissolution.

A temporary suspension of the heart's action is the chief sign of apparent death; a total arrest of its contractions is real death. Some of the vital endowments of the blood and muscles survive this cessation of the heart's action; and the lingering irritability of the heart itself, and especially of the right auricle, forms our ground of hope in the use of means of resuscitation. This suspension or total arrest of the heart's action, or, in other words, apparent or real death, may be brought about by different causes, of which some act directly on the heart, others indirectly through the lungs.

The causes of sudden death which act directly on the heart are —1. *Structural diseases of the heart itself, and of the large vessels.* 2. *Nervous shocks paralysing its muscles.* 3. *Causes cutting off its supply of blood.* 4. *Causes destroying the stimulant property of the blood.*

1. The structural diseases of the heart and large vessels—hypertrophy, valvular disease, aneurism of the aorta, and ossification of the heart, aorta, or coronary arteries—are readily discovered on post-mortem examination. The only diseases of the heart which might escape observation are atrophy and fatty degeneration of its muscular tissue; and there is reason to believe that both these are occasionally overlooked. In two cases related by Mr. Paget, death really due to fatty degeneration was believed to have been caused by poison.

2. The nervous shocks of sufficient force to paralyse the heart, and to cause instant or speedy death, may be caused by strong and sudden emotions of fear and joy, by lightning and the sunstroke, by heavy blows on the head or pit of the stomach, by violent exertion causing sudden effusion of blood on the brain (of

which one case has come under our notice), by large drafts of cold water swallowed when the body is heated, and by a few of the more active poisons in full doses.

3. The supply of blood necessary for the heart's action may be cut off by profuse hæmorrhage. It may also be kept from the left side of the heart by the arrest of the circulation through the lungs in death by apnœa. But this belongs to the class of indirect causes.

4. The proper constitution of the blood may be destroyed mechanically by the admixture of air introduced into the veins during operations on the neck, shoulder, or axilla; and chemically by poisons directly introduced into the circulation. This contamination of the blood plays an important part in death by all active and deadly poisons, whether inhaled or swallowed.

Of the causes of sudden or speedy death which act indirectly upon the heart, the most common is that arrest of the circulation through the lungs which attends the several forms of suffocation. A similar arrest constitutes the intermediate link between the less severe shocks to the nervous system and the ultimate stoppage of the heart's action.

Several of the foregoing causes of sudden death are at once revealed by a careful inspection of the body; but those causes which do not leave behind them any structural change may yet give rise to such marked changes in the distribution of the blood through the body, and in and about the heart, as to aid us materially in our inquiries into the true cause of death. Thus, death from the rapid loss of blood would be indicated by pallor of the surface, and the empty and contracted state of all the cavities of the heart; death from shock suddenly arresting the circulation, by a distended state of all the cavities of the heart; and death from suffocation by violet patches on the surface of the body, and distension of the right side of the heart with dark blood.

The causes of sudden death, and the post-mortem appearances by which they are indicated, may be more fully discussed by adopting the well-known classification of Bichat—namely, death beginning at the *head*, *heart*, and *lungs* respectively.

Sudden Death commencing at the Heart.—Syncope.—The phenomena which attend this form of death are:—Pallor of the face and lips, cold sweats, dizziness, dimness of vision, dilated pupils, gasping and sighing respiration, a slow, weak, and irregular pulse; to which are sometimes added nausea and vomiting, restlessness and tossing of the limbs, transient delirium and convulsions. On inspecting the body, the vessels generally are

found to contain little blood, and the *heart to be nearly or quite empty, and contracted.* This empty state of all the cavities of the heart contrasts strongly with their distended state in the rare cases of death originating in the brain, and acting directly upon the heart: and not less strongly with the distended condition of the right side of the heart, and empty state of the left, which occurs in death commencing in the lungs.

Sudden Death commencing at the Head.—Injuries to the nervous centres may act directly upon the heart, and stop its contractions: or they may first affect the function of respiration by paralysing the respiratory muscles. When the heart is directly affected, the circulation is, as it were, arrested and fixed in what may be termed its normal state, each side of the heart containing its due proportion of blood, and all the cavities being distended from the sudden loss of power in the heart to propel its contents. This mode of death has been designated *asthenia.* When, on the contrary, the muscles of respiration are paralysed, the post-mortem appearances will be those presently to be described under the head of apnœa.

Sudden Death commencing at the Lungs (*Asphyxia*).—The sense now affixed to the term asphyxia departs strangely from its original derivation, which means pulselessness. It is now understood to mean real or apparent death due to a suspension of the function of respiration,—a mode of death much better defined by the term *apnœa,* of which the following are the chief causes :—1. *Cessation of the action of the muscles of Respiration.* 2. *Cessation of the action of the Lungs themselves.* 3. *Exclusion of air from the Lungs.*

1. *Cessation of the Action of the Muscles of Respiration* may be due to *inertia* of the muscles themselves, in consequence of cold or debility; to *a loss of nervous influence supplied to the muscles,* as from division of the upper portion of the spinal marrow, or of the pneumogastric and phrenic nerves, from the lightning stroke, and from apoplectic seizures; to *mechanical restraint,* as by pressure on the chest or abdomen; or to *tonic spasm,* as in death from Tetanus or Hydrophobia.

2. *Cessation of the Action of the Lungs.*—This may be due to a division of the eighth pair of nerves; or to a mechanical obstacle, such as the admission of air into the pleuræ, or the intrusion of the viscera of the abdomen through a wound in the diaphragm.

3. *The partial or complete Exclusion of Atmospheric Air from the Lungs* may be brought about by the entire absence of air, as in a vacuum; or by its extreme rarefaction, as on the top

of very lofty mountains. The air, again, may be mechanically excluded, by a foreign body in the larynx, by submersion, by suffocation, by strangulation, by suspension. Or lastly, the place of the atmospheric air may be taken by a gas, such as nitrogen or hydrogen, which cannot support respiration. Other gases seem to exercise a deleterious influence on the economy, independent of the mere exclusion of air. Some of these are intensely irritating, as the sulphurous acid gas, chlorine, and ammonia; others, though less irritating, are not less fatal, such as the carbonic acid, carbonic oxide, carburetted hydrogen, nitrous acid, hydrosulphuric acid, hydrosulphate of ammonia, arseniuretted hydrogen, and the vapour of hydrocyanic acid. Some of these, as well as the simply irritant gases, may act mechanically by producing spasmodic closure of the glottis.

To this list of the causes of apnœa may be added certain diseases of the lungs, as hepatization, œdema, or tubercular infiltration, which prove fatal by filling the air-cells, and preventing the process of respiration from being duly performed.

The *symptoms* of apnœa are more or less strongly marked according as the asphyxiating cause acts suddenly or slowly. If the atmospheric air is suddenly excluded from the lungs, as by mechanical compression of the trachea, complete submersion, or the inhalation of a gas which causes spasmodic contraction of the glottis, the symptoms are strongly marked, and run a rapid course. The sufferer struggles violently for breath, and uses strong efforts to remove the obstruction. The face flushes, and soon grows turgid and livid; the veins of the head and neck swell; the eyeballs start from their sockets: and the swollen tongue protrudes between the teeth. A short attack of giddiness, with bright spots before the eyes, and ringing sounds in the ears, is followed by loss of consciousness, convulsions of the limbs, and relaxation of the sphincters, with expulsion of the prostatic fluid, of the urine, or of urine and fæces. In two or three minutes, if relief be not given, life is extinct.

When the asphyxiating cause acts more slowly, the symptoms are somewhat modified, and succeed each other at longer intervals. There is a feeling of constriction in the chest, from which the sufferer tries to free himself by strong voluntary efforts to inspire, or by the involuntary efforts of yawning or sighing. A dull heavy pain in the forehead, with giddiness, dimness of sight, and torpor of the intellectual faculties succeeds, and gradual loss of sensation and voluntary motion. Still, the functions of respiration and circulation continue, as shown by almost imperceptible movements of the walls of the chest, and pulsations of

the heart scarcely sensible to the hand. This imperfect state of respiration and circulation is followed by the entire cessation of those functions, and by complete loss of motion, voluntary and involuntary. At this point of time the fulness of the capillary system begins to show itself, by a deep violet discoloration of the face, which also extends to the hands and feet. Some portions of the trunk and extremities exhibit spots more or less extensive, of the same colour. At length, the capillary circulation ceases, and the state of apnœa is complete.

In some cases the asphyxiating cause, acting more slowly still, induces a sleep which terminates, without suffering, in death; in other instances, the sensations are even pleasurable, consisting of a display of beautiful colours or of pleasant landscapes before the eyes. There is still another class of cases in which the sufferer, suddenly roused from a state of torpor to a vivid and painful perception of his state, tries to escape from the death which threatens him, but his strength fails, and he falls to the ground.

The post-mortem appearances are the following:—Patches of rosy, bright red, or violet discoloration on the face or on other parts of the body, as much on the least as on the most depending parts. The eyes usually prominent, firm, and brilliant. The mouth sometimes expressive of calmness, at others of suffering. Cadaveric rigidity strongly marked and persistent. The venous system of the brain commonly full of blood, but its substance presenting, when divided, few bloody points. Sometimes the ventricles of the brain contain serum; sometimes blood is effused at the base, in the substance, or on the surface, of the organ. The base of the tongue is almost always injected, and its papillæ are strongly developed. The lining membrane of the epiglottis, larynx, and trachea, of a deep red colour, becoming more intense as we approach the last ramifications of the air-tubes. The air-passages often contain a bloody froth. The *lungs* are so much distended and enlarged as to project over and conceal the pericardium. They are of a deep violet colour, and when cut into and compressed, large drops of black, thick, liquid blood exude. The liver, spleen, and kidneys, are also gorged with blood. The veins of the heart are distinctly traced upon its surface, its right cavities and the large venous trunks are gorged with black, thick, liquid blood; but its left cavities are found nearly or quite empty.

Such are the appearances present in death by apnœa when it occurs in its unmixed form; and they are those observed in the bodies of persons who have perished by inhaling carbonic acid. But all these appearances are not present in every case, nor, if present, are they equally marked in all.

Theory of Apnœa (*Asphyxia*).—When air is prevented from gaining access to the lungs, the blood does not undergo its usual change from venous to arterial, and venous blood does not minister to the support of the vital functions of the several organs so completely as arterial blood does. Some, indeed, have supposed that venous blood is a positive poison; and that it is much worse for an organ to be supplied exclusively with venous blood than to receive no blood at all.

On this assumption, the cessation of the heart's action may be explained in one of three ways. The heart may be paralysed by the circulation of venous blood through the coronary arteries in place of arterial blood; or the venous blood may be unfitted to excite the left cavities of the heart to contraction; or, again, the motive power derived from the nervous centres may be suspended by the circulation of venous blood through them.

But the assumption that venous blood is directly poisonous, and worse than no blood at all, has been disproved, as far as it can be, by experiment. Kay has shown that it has no deleterious influence on the muscles, by comparing the contractility of a limb from which the supply of arterial blood has been cut off with that of a limb supplied exclusively with venous blood; and Edwards found that a cold-blooded animal lives longer in an asphyxiating medium than one whose heart and bulb of the aorta have been excised.

The circulation of venous blood, therefore, is merely a negative injury, and destroys life by occupying the place of arterial blood. As the absence of all circulation through the vessels of the heart, or through those of the brain, or through the nerves supplying the heart with vital stimulus, would certainly and speedily destroy life, so would the mechanical exclusion of arterial blood from the vessels of those parts, whether by warm water or by venous blood. This theory of exclusion, then, is adequate to the explanation of death by apnœa. It was shown, however, by Dr. Kay, that neither this theory, nor the theory of poisoning by a deteriorated blood, is the true one; but that the essential character of this form of death consists in the accumulation of blood in the lungs and right cavities of the heart, and a diminished supply of that fluid to its left cavities; so that the quantity of blood sent out for the supply of the system constantly diminishes, till at length the circulation ceases. Hence in death by apnœa the left ventricle is found contracted, and nearly or altogether empty. The proximate cause of this arrest of the circulation through the lungs is of little importance; the fact is all with which, as medical jurists, we have to do.

On contrasting the post-mortem appearances proper to the

three modes of death, syncope, asthenia, and apnœa (asphyxia), it will be seen, that in the first, all the cavities of the heart are empty, or contain little blood; in the second all the cavities are full; and in the third, the right side is gorged with blood, while the left ventricle contains little or no blood.

The medical jurist should, however, bear in mind that the characteristic appearances of sudden death, due primarily to the heart, the lungs, or the brain, are not always equally marked; that they may be combined with each other in different proportions; and that a cause usually productive of the one may give rise to the other. Thus, a man may be threatened with suffocation (one of the causes of apnœa), and apprehension may give rise to sudden *syncope;* or a violent attempt to escape the threatened injury may burst a blood-vessel in the brain, and cause *apoplexy*. We must bear in mind the possibility of such combinations as these, in order that we may be prepared to understand the different appearances presented by those who perish from a common cause.

It may be useful to subjoin the following facts connected with sudden death.

From the 19th Annual Report of the Registrar-General, it appears that of 416,470 deaths from all causes, occurring in England and Wales, on the average of the five years 1852–56, 13,711, or about 1 in 30, were violent deaths, of which 3045 were due to various forms of chemical injury, 3826 to apnœa (asphyxia), and the remaining 6840 to various mechanical injuries. Of the 13,711 violent deaths, 10,057 occurred in males, and 3654 in females. The sudden deaths, for the average of the same five years, are stated at 3843 or nearly 1 per cent. (1 in 109). They are distributed between males and females in the proportion of about 3 to 2.

The suicides on the average of the same five years amounted to 1083, of which 777 in men and 306 in women. Of 1044 due to ascertained causes, 642 were brought about by various forms of suffocation, 111 by poison, 1 by burning, and the remainder by mechanical injuries, among which 210 cut throats, 43 gun-shot wounds, 12 other wounds, and 20 falls. The suicides by poison of men and women respectively were as 6 to 5, by apnœa as about 3 to 1, and by mechanical injuries as about 4 to 1. The greatest number of suicides in both sexes occurred between the ages of 45 and 55.

The relative frequency of the several forms of sudden death appears, from a work of Ferrario and Sormoni on sudden deaths occurring in Milan, to be as follows:—

Head (including apoplexy, cerebral concussion, vertigo, and coma) . . .	879 or about 4 in 5.
Heart (including diseases of the heart, angina pectoris, aneurism, and hæmorrhage)	150 or about 1 in 7.
Lungs (including asphyxia, suffocative catarrh, and pulmonary apoplexy) .	14 or about 1 in 75.
Difficult labours	5
Total	1048

The relative frequency of the different forms of sudden death classified according to their proximate causes must, however, be understood to differ at different periods of life. The proportions just stated are obviously those which obtain chiefly among adults; for sudden deaths in infancy and childhood, if classed according to their causes, would reverse the order just stated. By far the most common cause of death in infancy and childhood is to be found in the lungs, and the least common in the brain, though the fact of convulsions being very common in early life might lead a superficial observer to attribute the majority of sudden deaths to the brain and not to the lungs. The diseases of the lungs which give rise to sudden or speedy death in infants and young children are spasmodic croup or laryngismus stridulus, to which Dr. West attributes three out of four of the sudden deaths of children under one year, imperfect expansion of the lungs at birth (atelectasis pulmonum), sudden collapse of the lung, consolidation from pneumonia, and sudden serous effusion into the pleura, to which ought to be added a disease not mentioned in the paper now referred to, pulmonary apoplexy. A not uncommon cause of sudden death among the children of the poor is suffocation, as a consequence of drinking hot water from the spout of the kettle. Next to diseases of the lungs, sudden death by exhaustion from insufficient food, or chronic diarrhœa, is most common, while fatal disorders of the brain are very rarely to be set down among the causes of sudden death in infancy and childhood.* Of the sudden deaths entered in the tables of the Registrar-General upwards of one third occur in infancy.

SURVIVORSHIP.

When two or more persons die by the same accident, a question may arise as to which died first; for, in certain cases, the succes-

* See a Lecture by Dr. West, on Sudden Death in Infancy and Childhood, in the 'Medical Times and Gazette,' Nov. 26, 1859.

sion to property would be secured on proof of survivorship even for an instant.

Hitherto little has been done towards establishing general principles applicable to this class of inquiries: indeed, the materials for the establishment of such principles are wanting. Some of the more accurate results which have been attained will be found stated under the following heads:—1. *Of the probabilities afforded by age and sex, irrespective of the mode of death.* 2. *Of the degree in which such probability is affected by the mode of death.*

I. OF THE PROBABILITIES AFFORDED BY AGE AND SEX.

Age.—As the body attains its full growth and strength at about 27 years of age, or from 25 to 30, and, in healthy persons, continues strong and vigorous up to about 50, there will be no sufficient ground for inferring survivorship in the case of adults of the same sex, whose ages range between 25 and 45, or even between 20 and 50, provided the form of death is one in which mere strength of frame and power of endurance is concerned. Before and after the ages specified, the strength and power of endurance will be less, but still within the limits of puberty and old age (say 15 and 60 years) the difference will probably be inconsiderable. The probability of survivorship, in the case of a middle-aged adult perishing with one under puberty or above 60, will be in favour of the adult. In the case of one under 15 and one above 60 perishing together, the French law assumes that the former survived: when both are under 15, that the elder outlived the younger. According to the civil law of England, if parent and child perish by a common death, the child shall be presumed to have survived if above, and to have died first if under, puberty.

In the case of a mother and child both dying in childbed, without assistance, the presumption is, that the mother survived, for there is a chance of still birth, and a further probability that the child, if born alive, would die before the mother could render the assistance necessary for its preservation. A large child would be still more likely to perish first, for it has been elsewhere stated that still-born children greatly exceed in size and weight those born alive. If the body of the child could be examined the presumption might be still further strengthened by the external marks of a difficult labour, or the absence of the signs of respiration. Legal decisions have not been always in conformity with the principle here laid down.

Sex.—If one of either sex perish by a common accident, it may be inferred that the male, being the stronger, is the survivor; but this rule applies only to modes of death in which strength and courage give the best chance of safety. On the other hand, females being subject to prolonged faintings from fright, may be, by that very circumstance, incapacitated from those struggles which in so many forms of death may be presumed to increase danger. When, then, there is safety in exertion, the probability of survivorship will be with the male; when in passive endurance or insensibility, with the female.

II. OF THE DEGREE IN WHICH THE FOREGOING PROBABILITIES ARE AFFECTED BY THE MODE OF DEATH.

Under this head some common modes of death will be specified, and an attempt will be made to establish some general principles with respect to them, assuming, as before, that the parties about whom the question is raised are placed, as nearly as may be, in the same circumstances.

Apnœa (*Asphyxia*).—Women consume less oxygen than men; the same quantity of air, therefore, will last them for a longer time. Hence, of adult males and females perishing together by apnœa, the females may be presumed to have survived. In poisoning by carbonic acid gas, which is nearly allied to death by apnœa, the chances of survivorship are with the female. This statement rests on the authority of a large number of facts. In 19 out of 360 cases of poisoning by carbonic acid, which took place in Paris during 1834 and 1835, a man and woman were exposed to the fumes of charcoal together: of these, three only were saved, and these three were females. In solitary cases of the same form of death the result is also favourable to the female; for 18 out of 73 females were restored, and only 19 out of 83 males, so that the chances for the female and male respectively are nearly as 15 and 14 (instead of 5 and 4 as Devergie represents it). Single cases are in conformity with this result. Thus, in a case quoted by Beck from the 'Transylvania Journal,' a man and his wife were exposed in a small room to the gas from live coals. The man was found dead, rigid, and contracted, but the woman was still breathing, and recovered. Again, in a case reported by M. Sardaillon, a man, his wife, and their child, aged seven years, were asphyxiated in a porter's lodge. The child died, the father was very ill and with difficulty restored to life, while the wife was well enough to call for help and to assist both husband and child. In these cases it is necessary to take

into account the position which the parties occupied in the room, whether on the bed or on the floor, near to or remote from an open window, &c.

Drowning.—There are many complicated considerations connected with this mode of death. In shipwrecks men are more likely to be in a favourable situation for saving themselves, as they are more on deck than women; they also in many instances are able to swim, or to save themselves by clinging to portions of the wreck, and they are less encumbered by clothing. When the comparison is between men similarly exposed and capable of the same exertion, it may be necessary to inquire whether one was more exposed to cold by having the body half immersed, while the other was more under water. Search should also be made for severe injuries which may have prevented the swimmer from using his strength, or may have otherwise proved fatal. Apoplexy is stated by Devergie to be sooner fatal than apnœa, while in death by syncope there is the best chance of recovery.

Suffocation.—In all cases of suffocation depending upon an insufficient quantity of air, or upon air rendered partially unfit for respiration, it may be presumed that those who require least air live the longest—women longer than men, children than adults. In suffocation from the falling of houses or earth, or by mechanical means in general, the stronger may be presumed to survive the weaker—men, women; adults, children and old persons.

Cold.—As young children bear cold worse than adults, the probability of survivorship in exposure to the same degree of cold is in favour of the latter. Men bear cold better than women, adults better than the aged. It is necessary also to take into account the clothing of the exposed persons, and their state of health. Spirituous liquors in excess increase the effect of cold; in moderation they give increased tolerance of it.

Heat.—The young and old, as they suffer more from cold, so do they bear heat better. The relative tolerance of heat of the two sexes is not well ascertained. Foderé relates the case of an Englishman and his daughter aged seven years, who, in the year 1814, crossed the desert of Syria to the Persian Gulf. Both rode on camels, and were placed in precisely similar circumstances, but the father died, while the child arrived in safety at its journey's end.

Hunger and Thirst.—Those who have not reached their full growth require more nourishment than adults, and adults more than aged persons. The aged, then, if healthy and robust, may be presumed to survive both, and the adult to live longer than the child. Corpulent persons are thought to bear hunger better

than the emaciated. In death from starvation, those who have the freest access to water may be presumed to live the longest. Those who use the greatest exertions will suffer earliest in this as in the foregoing modes of death. Those who possess most passive endurance may be expected to live the longest.

Such are some of the principal forms of death, in which the circumstances of the several victims are likely to be so similar as to admit of the application of general rules. In other modes of death, and in these under certain circumstances, there may be no points admitting of strict comparison, and many things which may exercise a marked influence on the result will have to be taken into account. The reader will find several such cases quoted in Beck's 'Medical Jurisprudence;' but as they throw little light upon the general question, and establish no fixed principles, they are not quoted here.

It has been suggested that a distinct enactment would be preferable to the present custom of deciding each case on its own merits. Such an enactment, extending to that large class of cases in which the circumstances of the death are but imperfectly known, and to those in which it is in the very nature of things impossible to come to a correct decision, is certainly much to be desired. On many points, as has been seen, the opinions of medical men can throw much light, and their researches lead to general principles admitting of tolerably safe application.

CHAPTER II.

DROWNING—HANGING—STRANGULATION—SUFFOCATION.

THESE modes of death are brought together in the same chapter, as they are all forms of apnœa, or death beginning at the lungs.

DEATH BY DROWNING.

The medico-legal importance of this subject may be inferred from the fact, that on an average of the five years 1852-56, 2352 deaths were caused by drowning, of which 1847 in males and 505 in females. Of this number 164 (87 males and 77 females) were ascertained acts of suicide.

Death by drowning is commonly attributed to apnœa, but it is not always due to that cause. Hence this subject is not so simple as at first sight it would seem to be. To make it intelligible it will be necessary to describe the various modes in which a man who has died in the water may have come by his death.

When a man in perfect possession of his faculties falls into the water, he sinks to a greater or less depth, but immediately rises to the surface again; and, if he is a swimmer, makes efforts to save himself, till at length he is reduced to the condition of one who cannot swim at all; with this difference, that he has already exhausted the strength which the other has in reserve for the death-struggles common to both. These struggles consist of irregular movements of the arms and legs, and graspings of the hands at all objects within reach, whether floating in the water, fixed at the bottom, or growing on the banks. In the course of these irregular movements he rises repeatedly to the surface, tries to breathe, and takes in air and water. The contact of the water with the windpipe causes a cough, by which part of the fluid is rejected, and with it some air from the lungs. This occurs again and again, till the body no longer rises to the surface; water alone is received in the vain efforts to respire, while forcible involuntary expirations continue to expel the air from the chest. At length all these efforts cease, the body sinks

to the bottom, and bubbles of air are forced from the chest by the elastic reaction of its parietes. The greater part of the water which has entered the mouth finds its way into the stomach, the rest into the lungs; and this residue, mixed with the secretions of the mouth and air-passages, and frothed by the air inspired and expired, forms the foam so constantly met with in persons who have perished in this way.

In cases belonging to this class, we may expect to find the appearances proper to death by apnœa, coupled with those due to the medium in which the death takes place. In the case of the swimmer death may take place from exhaustion, with less distinct signs of death by apnœa.

But death may take place in the water, and yet be caused neither by apnœa nor by exhaustion. There may be complete loss of consciousness at the very moment of immersion. This may happen from fright, from drunkenness, from an attack of hysteria, or of catalepsy (of which we have known one instance); and in this case the body falls to the bottom, rises again to a certain height, and sinks without a struggle. In these cases death is due to shock, or to syncope.

Again, a man may fall or throw himself into the water head foremost, and, striking against a rock or fragment of wood, or even against the water itself, perish by concussion; or the body falling or thrown from a height may strike the water with the chest and pit of the stomach, so as to cause instant death from shock.

Again, cold, excitement, or the first violent struggles, may occasion apoplexy, or sudden death from disease of the heart. These sudden deaths by diseases of the brain and heart are of occasional occurrence in persons bathing in cold shallow water.

Death by drowning may also be of a mixed character. A man falls into the water in full possession of all his faculties, which he preserves for a time, till, struck with horror at the death which threatens him, he faints, and thus perishes.

It appears, then, that death by drowning may be due to apnœa, to exhaustion, to shock, to syncope, and to apoplexy; and, further, that death may be brought about partly by apnœa, partly by one of the other causes now specified. The cases in which there exist marks of apnœa more or less distinct blended with those proper to some other form of death, are much the most common, while those in which the signs of apnœa are wholly absent form a small minority, and cases of pure and unmixed apnœa occupy an intermediate place. Devergie, whose large experience of the drowned has been already alluded to, estimates the cases

of unmixed apnœa as *two in eight* of the whole, the cases in which no traces of apnœa exist as *one in eight*, and the mixed cases as *five-eighths*.

The appearances in the body of the drowned must necessarily vary with the manner and cause of death.

In those cases in which death has been due to *apnœa*, the post-mortem appearances will be those proper to that mode of death (see p. 250), blended with those due to the medium in which the death happened, and modified by the time the body has remained in the water, as well as by the length of subsequent exposure to the air.

If the death was due to apnœa, and the examination was made soon after the death and removal from the water, it may be expected to present the following appearances:—The face and general surface of the body are either pale or slightly livid, with patches of a deeper tint. The expression of the face is generally calm. The tongue is swollen, and closely applied to the teeth, rarely protruded between the closed jaws, and still more rarely wounded and bloody; and there is a frothy foam at the mouth. The air-passages also contain a froth, which is sometimes tinged with blood; and the trachea and larger bronchial tubes contain water which sometimes penetrates to their most minute ramifications, and may be in such quantity as to fill the whole of the air-passages. The water occasionally carries with it portions of slime or mud, or fragments of aquatic plants. The lining membrane of the air-passages is sometimes congested; the lungs contain a large quantity of black fluid blood, which also distends the venæ cavæ and right side of the heart, while the left cavities and aorta are comparatively empty. The stomach almost always contains water, sometimes in considerable quantity. The intestines have a rosy colour; the liver, spleen, and kidneys are gorged with blood; and the bladder sometimes contains bloody urine. The brain presents the same appearances as in other cases of death by apnœa. Sand or mud is often found in the hollow of the nails, the fingers are sometimes abraded, and portions of plants growing in the water, or on the banks of the stream, may be found grasped in the hands. Injuries received in falling into the water during the death-struggles, or through the violence of the stream, may also leave their marks upon the body.

In bodies that have remained in the water, or been exposed to the air for some time, the pallid, or slightly livid hue of the features may be exchanged for a bloated appearance, and large livid spots may show themselves on different parts of the body as in other cases of death by apnœa.

In death by shock, syncope, or exhaustion, there is little or no water in the air-passages or stomach. The cavities of the heart and large vessels are equally distended with blood, or are nearly empty, and the brain and internal viscera are in their natural state.

Death by concussion or by apoplexy, or by disease of the heart, will reveal itself by the usual post-mortem appearances.

In mixed cases, the post-mortem appearances due to apnœa will be less strongly marked. There will be less froth at the mouth, less water and froth in the air-passages and stomach; and less congestion of the lungs, heart, and great vessels, and internal viscera.

Several medico-legal questions suggest themselves in reference to a body found in the water. The first in order is the following:—*Was death caused by drowning?* In the case of a body found in the water, death may obviously have happened from natural causes or from intentional violence prior to immersion; and in the latter case the death may have been due to some cause producing apnœa, and giving rise to the characteristic appearances proper to that mode of death. In other words, a person may be strangled or suffocated, and then thrown into the water to conceal the true cause of death. In deciding a question of so much difficulty, we shall have to consider the several post-mortem appearances alleged to be characteristic of death by drowning, and to determine whether they might have been occasioned by causes acting before immersion. We must also determine whether, in the case of bodies remaining in the water some time after death, the appearances usually attributed to the mode of death may not be explained by the circumstances of the immersion itself.

Of the post-mortem appearances present in bodies found in the water, some are peculiar to death by drowning, others common to death by other forms of apnœa. To the latter class belong the position and swollen state of the tongue; the pallor with rosy or violet discolorations of certain parts of the skin; the injected state of the brain; the congestion of the internal viscera; the greatly increased volume of the lungs; the fulness of the right cavities of the heart, and emptiness of the left; the fluid state of the blood; and the existence (very rare) of bloody urine in the bladder. To the former class belong:—excoriations of the fingers, with sand or mud in the hollow of the nails; fragments of plants grasped in the hand; water in the stomach; froth at the mouth and nostrils; froth, water, mud, or sand in the air-passages; and retraction of the penis.

Of the appearances common to drowning and to death by other

forms of apnœa, it will suffice to observe, that their presence in persons found dead in the water is consistent with the supposition of death by drowning.

The post-mortem appearances alleged to be due to drowning, and to be characteristic of it, must now be briefly considered.

Excoriations of the fingers are much more often absent than present; but, when they exist, may be regarded as a probable, though not certain, sign of death by drowning. They might be caused previous to forcible immersion, by the rubbing of the fingers against any hard and rough body; and possibly after death in running streams.

Sand or mud in the hollow of the nails, also, affords a probability of immersion during life, for it implies, like excoriations of the fingers, that the drowning man grasped at the bed or banks. But if the body remained long in the water, mud or sand might be deposited in the nails.

Hands clenched and *grasping weeds growing in the stream or on the banks,* afford the strongest probability of death by drowning.

Water in the Stomach.—The discovery of water in the stomach also affords strong presumption in favour of death by drowning; especially if the water (or other fluid) can be identified with that in which the body was found by its containing leaves of plants growing on the banks or at the bottom. Except in the cases presently to be mentioned, it presupposes acts of deglutition during efforts to breathe. It must, however, be admitted to be possible, though very unlikely, that the water might have been swallowed a very short time before submersion.

The quantity of water is very variable; and depends partly on the number of respiratory efforts made during the act of drowning, and partly on the depth of the water. In animals stunned before immersion, as well as in those kept under water from the first, and prevented from rising to the surface, the stomach contains no water; while in animals allowed to rise to the surface, it is found to be in proportion to the number of times that they so rise.

That the depth of water also influences the quantity found in the stomach is proved by the experiments of Dr. Taylor. The stomach of a cat held two feet below the surface of the Thames contained scarcely any water; but that of a cat lowered to the depth of fifty-five feet contained a large quantity. The stomach of a third cat which was allowed to rise repeatedly to the surface, was distended, but not so much as the one that had been lowered to the depth of fifty-five feet. The columnar pressure of the

water is, therefore, considerable; and it is probable, that where the water is very deep it may force the passage of the œsophagus, even though the animal died previously to submersion. But it has been shown by repeated experiments on animals that, as a rule, water does not enter the stomach after death. It appears, moreover, that water may enter the stomach when the tissues have been relaxed by putrefaction.

It is obvious, then, that water in the stomach is not to be considered as conclusive evidence of death by drowning, when the water is of great depth, or when the body is far advanced in putrefaction. It must also be admitted to be possible that the water might have been swallowed immediately previously to immersion, and possible, also, though most improbable, that it might as suggested by Orfila, be maliciously injected after death.

But though water in the stomach affords a presumption of death by drowning, its absence must not be taken as evidence to the contrary; for it is not present in death by drowning due to causes other than apnœa, such as shock, syncope, concussion, or apoplexy. The tendency to swallow may also be voluntarily resisted; or the body may be, in some way or other, prevented from rising to the surface.

On the other hand, water may have entered the stomach, and yet not be found there after death; for if the head be allowed to hang down, the water will escape. This fact also was proved by Dr. Taylor's experiments. Again, lengthened exposure after removal from the water, may cause the fluid in the stomach to transude through its coats, and disappear.

The absence of water from the stomach, therefore, is not conclusive against death by drowning, for it may have entered the stomach, and subsequently disappeared; or it may never have entered the stomach at all.

Froth, water, mud, or sand, in the Air-Passages.—Mucous froth.—From experiments on animals made by Piorry and Orfila, the presence of mucous froth in the air-passages was inferred to be due to the body rising repeatedly to the surface for air. In animals kept entirely under water no froth was found; and it was also absent when the body remained in the water a long time, or was subject to long exposure after its removal; as also when the head was placed downwards. But Casper, as the result of numerous observations, declares that these experiments do not admit of application to the human subject. He found froth in the trachea equally in those who could, and those who could not, have risen to the surface.—(Handbook, vol. ii. p. 238). The value of this mucous froth as evidence of death by drowning

is also impaired by the fact that it exists not only in the several forms of death by apnœa, but in death by apoplexy or epilepsy, and in catarrhal and other affections of the lungs.

Water in the Lungs.—That water generally enters the lungs in death by drowning has been abundantly proved by experiments on animals, and by cases in the human subject in which not only water but sand and mud, and leaves of plants, have entered the air-passages. By drowning rats in chalk and water, with free access to the air, I have never failed to obtain effervescence by means of acids in every part of the lungs.

But the value of this sign is impaired by the fact that water may enter the lungs of those who have been thrown in after death. Orfila and Piorry found, that the quantity which thus gained admission to the lungs, varied according to the position of the body, being large when it remained upright: less when horizontal.

The suggestion that water may be *injected* after death may be treated as a fanciful refinement. But water is not always present in the lungs in death by drowning; for, as in the case of the stomach, if the head is placed downwards, the water flows out. Long exposure, too, will cause it to transude and be lost.

Froth at the Mouth and Nostrils.—This, too, is a sign of death by drowning; but it is open to all the objections just stated in respect of froth in the air-passages. It has, indeed, a very close dependence on the existence of froth in the air-passages, aided by the development of the gases of putrefaction forcing it into the fauces. Hence it is more common in summer than in winter.

Retraction of the Penis.—Casper alleges that, in men who have fallen into the water alive, and died by drowning, he has almost never failed to find this appearance, while he has not observed a similar appearance so constantly after any other kind of death. (Handbook, vol. ii. p. 236.)

From this examination of the signs of death by drowning, it appears that there is no single one on which entire reliance can be placed. But when several signs coincide, the probability is greatly strengthened. Like the symptoms of disease, they may be of little value when taken separately, but when combined they enable us to form a safe diagnosis. Some authors, and Orfila among the number, have, indeed, thought that the question, Was death due to drowning? admits of no decision; but from this opinion Devergie and Casper very properly dissent.

It should also be borne in mind, that the most characteristic appearances of death by drowning are not permanent. In winter

they may continue after the body has lain from fifteen to eighteen days in the water, while in summer they may disappear as early as the third day. Exposure to the air also causes them rapidly to disappear, and in the height of summer a few hours might suffice to dissipate them. When putrefaction has gone to any considerable extent, all the signs of death by drowning are of course completely removed.

The time that the body has remained in the water will be determined approximately by the signs laid down at p. 243.

The evidence derived from the signs of death by drowning already discussed admits of being confirmed or invalidated by the condition of the body in other respects, especially by the presence or absence of

Marks of Violence.—With regard to injuries on the bodies of persons found in the water, three questions arise:—

1. Were they inflicted during life?

2. If so, are they such as to account for death before submersion?

3. Were they accidental, suicidal, or homicidal?

The first and third questions are fully discussed under the head of wounds. The immersion of the body in water will influence the decision of these questions, only in so far as the injuries are thereby altered in appearance.

Are the Injuries such as to account for death before Submersion.

There are five ways in which a body taken from the water may come to exhibit marks of violence. 1. A man may be murdered, and thrown into the water dead; 2. He may receive severe injury from the hands of others or himself, and may then be thrown (or throw himself) into the water while still alive. 3. The bruises may have been caused by the death struggles. 4. The corpse may be borne by the stream against some obstacle. 5. The body may sustain severe injury in the very act of falling into the water.

1. In a man who has been murdered and thrown into the water dead, we should expect to find all the signs of death by drowning absent, with the exception of such as may have been caused by uncommon depth of water, or advanced putrefaction.

2. On the supposition that a man found in the water had first been severely injured and then thrown in alive, we might expect to find some of the signs already mentioned, proportioned in number and distinctness to the strength still left after the violence inflicted.

3. The injuries caused by the struggles of the drowning man

would consist of bruises more or less distinct, but not so severe or extensive as to endanger life.

4. The injuries inflicted on the body by the violence of the stream would also consist of bruises more or less extensive. It is not likely that such severe injuries as dislocations or fractures could originate in this way.

5. *Falling into the Water.*—A person who falls or throws himself from a height upon a hard bank or pier of a bridge, may sustain very severe injuries, such as fractures of the skull or limbs, extensive bruises, and severe lacerated wounds.

Dislocation of the limbs is also a possible consequence of the resistance presented by the water to the body falling from a great height. This happened many years since, as stated by Dr. Gordon Smith, to a man who used to jump from the parapet of London Bridge into the Thames for a wager. He had previously performed the feat with impunity, but the last time he sank and was drowned. Both arms were found dislocated, in consequence, it is thought, of his having fallen with them stretched out instead of close to his sides, as was his wont.

Two cases are also recorded (South's edition of Chelius's Surgery, vol. i. p. 532), the one of fracture of the body and arch of the fourth cervical vertebra, the other of fracture of the body of the fifth vertebra, caused in jumping into the water. The deaths were attributed to a sudden retraction of the head to avert collision with the bottom.

The medical man should, therefore, ascertain whether the drowned man fell from a height into the water, whether the stream is rapid, and what obstacles present themselves; and if on careful examination he finds that there are no such causes as these to account for the injuries sustained, he may fairly trace them to some cause preceding the immersion. In bodies found in shallow still water, marks of violence afford strong presumption of homicide.

Assuming death to have been due to drowning, another question arises—

Was the drowning the result of Accident, Suicide, or Homicide?—This question is exceedingly difficult to answer; for if there are no marks of violence on the body, it is not possible to say whether the man fell in, or jumped in, or was pushed in. Again, in respect of bodies found in running streams, it may not be possible to ascertain at what point they entered the water; hence we are deprived of such information as might have been obtained from a close examination of the spot where the body is found.

Nor if we find the hands of the drowned man full of leaves or grass, showing that he struggled hard while in the water, can we affirm that he was thrown or pushed in by others; for, if he fell in, he would do the same.

Nor again, does the fact of a man being drowned in a shallow stream of water exclude the idea of homicide; for if a strong man were to hold the head of a weak or infirm one in a basin of water, he might drown him just as effectually as in a deep stream. On the other hand, it should be borne in mind that cases of suicidal drowning in shallow water, or in very narrow spaces, such as small house-cisterns, are by no means rare.

It is evident, from what has been stated, that where there are no marks of violence on the body, we have no means of determining whether the drowning was the result of accident, suicide, or homicide; and that external injuries, to throw any light upon the question, must be such as could not have been inflicted by the drowned man himself prior to immersion, or by the accidental striking of the body against an obstacle in entering the water, or during the death struggle.

There is one case which would at first sight seem conclusive of homicide, namely, where a body is found in the water tied hand and foot. Dr. Smith, however, relates the following case:—In July, 1816, the body of a gauging-instrument maker, who had been missing for some days, was discovered floating down the Thames. On being taken out, his wrists were found tied together and made fast to his knees, which were in like manner secured to each other. He had been deranged for two years. The cord with which he had tied himself was recognised as the one with which he used to raise himself in bed. He was a good swimmer, and probably took the precaution of disabling himself. The verdict was "Found drowned." Two similar cases are on record, one by Foderé, in which the hands and fingers were tied together with a silk riband, in numerous folds; and another in the ninth volume of the 'Annales d'Hygiène,' in which the feet, wrists, and neck were tied. Foderé in the one case, and the medical examiners (Marc, Guichard, &c.) in the other, gave their opinion in favour of suicide. In such cases as these it would be necessary to determine whether the knots or folds admitted of being made with the teeth, or by any movements of the hands or limbs.

Treatment of the Drowned.—Before describing the proper treatment of the drowned, it may be well to recall the fact that in most deaths by drowning the cause of death is apnœa, simple or mixed; and that the means to be adopted are those which would be prescribed in other cases of suffocation, with certain

obvious modifications suggested by the death having occurred in the water. The contact of the water, for instance, lowers the temperature of the skin, and renders necessary more prompt and sustained attempts to restore it. The lungs and stomach should also be relieved of the water which had entered them.

The following rules for the treatment of the drowned are in accordance with the method of Dr. Henry Silvester, which has now, by general consent, taken the place of that recommended by Dr. Marshall Hall. Send immediately for blankets and dry clothing, but treat the patient instantly on the spot, in the open air. First place the body, for a few seconds, with the face downwards, the head lower than the feet, the mouth open, and the tongue drawn forward; then turn the body on the back, place it on an inclined surface, raise the shoulders and support them, and fix the feet. Now grasp the arms at the elbows, draw them above the head and keep them on the stretch for two seconds, then reverse the movement for the same length of time, pressing the arms firmly against the sides of the chest. Repeat this twofold movement fifteen times in the minute, till a spontaneous effort at respiration occurs. Then remit the movements, and proceed to promote the circulation and restore warmth by firm friction and pressure directed upwards, by hot flannels, bottles, bladders of hot water, or heated bricks; or borrow warm clothing from the by-standers. Respiration may be promoted by smelling salts, tickling the throat with a feather, and by the alternate dash of cold and warm water on the face and chest. When the respiration is restored, warm brandy and water, wine and water, tea or coffee, may be given, and the patient being put to bed, should be allowed to sleep. Our efforts to restore life should be persevered in for three or four hours, or till some certain sign of death has shown itself.

DEATH BY HANGING.

In the five years 1852-56, 494 persons perished by hanging, in England and Wales, of whom 384 were males and 110 females. Of the 494 deaths, 451 were ascertained suicidal acts, 394 by men and 102 by women. Judicial executions account for 7 of the deaths. In the whole five years only one death (of a child under five years old) was set down as an act of homicide.

As the cause of death is the same in hanging, strangulation, and suffocation, it may be well to make a few preliminary observations on these modes of death, before proceeding to examine them separately.

Though in common language, death from any of these three causes is due to *suffocation*, this term has in medico-legal language a distinct meaning of its own. When death is produced by an impediment to the respiration, which does not act by compressing the larynx or trachea, it is said to be due to *suffocation*. Thus a man is said to be suffocated if his mouth and nostrils are closed, or if the action of the muscles of respiration is prevented by mechanical pressure on the chest or abdomen. Certain noxious gases, too, are said to destroy life by suffocation. The subject of suffocation, then, separates itself at once from those of suspension and strangulation. Our attention, therefore, must be directed, in the first place, to death by hanging, strangulation, and throttling, in all of which pressure is exercised on the *air-tube* and *throat*.

The most simple cause of death is *throttling*—that is to say, direct pressure on the trachea with the fingers. Here the cause is obvious; it is the same as in many cases of drowning; the same as in suffocation—viz., *apnœa* (*asphyxia*). Death takes place from the mechanical hindrance to respiration. But the cause of death is not so clear when the entire circumference of the neck is subject to pressure; for in this case not only the larynx or trachea, but the blood-vessels also suffer. In some instances both air-tubes and blood-vessels are implicated; in others the air-tubes suffer compression and the vessels escape; in others, again, the air-tubes escape and the vessels sustain all the pressure. The respiration and circulation are most completely impeded when a cord is fixed round the lower part of the neck, so as to embrace the trachea, and the large vessels at their entrance into and exit from the chest; or when it is applied, or drawn by the weight of the body, beneath the lower jaw. Both functions are less interfered with when the cord is fixed directly over the larynx, as the projections of the os hyoides and thyroid cartilage afford some protection to the air-passage and blood-vessels.

This variation in the position of the ligature, and in the pressure which it exercises on the organs of respiration and circulation respectively, explains the difference in the length of time required to destroy life in all those cases in which death does not take place instantaneously from injury to the spinal cord; and the simultaneous compression of the air-tubes and blood-vessels gives rise to the question, whether the pressure on the air-tube or on the blood-vessels is the immediate cause of death. In other words, is death caused by *apnœa*, or by *apoplexy?*

It was formerly the general belief that death was due to

apoplexy: and this opinion was not unreasonable, for it is well known that mere pressure with the fingers on the carotid arteries will cause sleep, by checking the supply of blood to the brain, and that apoplexy is often brought on, in persons predisposed to that disease, by the pressure of a cravat impeding the return of blood through the veins. That apoplexy, therefore, may be brought about by pressure on the large blood-vessels is not to be doubted; but the question still recurs—in those cases of suspension or strangulation in which the air-tube and blood-vessels are simultaneously compressed, to which of the two pressures is death to be attributed? Both causes doubtless contribute to the fatal result, but the stoppage of the respiration is certainly the essential cause; for death by apnœa would be much more speedily and certainly induced by a complete or partial stoppage of the breathing, than fatal apoplexy by the complete or partial arrest of the circulation. But an appeal may be made to actual experiment for the decision of this question. A dog was suspended by the neck with a cord, an opening having been previously made in the trachea below the place where the cord was applied. After hanging for about three-quarters of an hour, during which time the circulation and breathing went on as usual, the animal was cut down, and did not appear to have suffered materially. The cord was then shifted below the opening into the trachea, so as to stop the ingress of air into the lungs; and the animal being again suspended, was in a few minutes quite dead.* In this experiment the compression of the vessels was probably less than it would be in many cases of death from hanging in the human subject, in which the violence employed, the height of the fall, and the weight of the body combine to tighten the cord, and thus exercise the strongest pressure on the vessels as well as on the air-tube.

A similar operation on the human subject is described by Smith.†

"A man of the name of Gordon was executed at Tyburn, in April, 1733. Mr. Chovet having, by frequent experiments on dogs, discovered that opening the windpipe would prevent the fatal consequences of the halter, undertook to save Gordon, and accordingly made an incision in his windpipe, the effect of which was, that when Gordon stopped his mouth, nostrils, and ears, for some time, air enough came through the opening to allow of the continuance of life. When hanged, he was observed to be alive after all the rest were dead; and when he had hung three-quarters of an hour, being carried to a house in the Tyburn road,

* 'Cyclopædia of Practical Medicine,' Asphyxia.

† 'Forensic Medicine,' Appendix, p. 561.

he opened his mouth several times and groaned; and a vein being opened he bled freely." But these were the only signs of life. Dr. Smith attributed the want of success to the great weight of the man, coupled perhaps with the insufficiency of the opening into the trachea. It is obvious that the same results would happen if an equal pressure by strangulation were substituted for the weight of the body.

It appears, then, that when the windpipe and the large blood-vessels suffer compression, death may be attributed to apnœa; that when the respiration is free, or but slightly affected, pressure on the vessels may cause death by apoplexy, but more slowly; and that when respiration and circulation are both impeded, both may contribute to the fatal result, though the hindrance to the respiration is the more efficient.

It has been suggested that the immediate cause of death in hanging and strangulation is pressure on the nerves which subserve the function of respiration; but as such pressure does not prove fatal till the lapse of many hours, this explanation may be rejected.

Having now examined the questions common to death by hanging and by strangulation, the subject of death by hanging may be resumed.

Death takes place very suddenly in certain cases of suspension, either from fear producing syncope as in some cases of drowning, or from injury to the spinal cord by luxation of the cervical vertebræ, fracture of the odontoid process, or rupture of the intervertebral substance. These injuries to the spine being caused either by the fall of the body from a height, or by a rotatory motion given to the body at the moment of the fall.

Death by hanging takes place, then, in different ways and at different intervals of time. The more speedy deaths may be traced to injury of the spinal marrow above the origin of the nerves of respiration, and, more rarely, to syncope from fright. Next in point of rapidity will be death from *apnœa*, and the least rapid that by apoplexy.

We are not without information as to the sensations that accompany death by hanging. Suicides saved from death, and philosophers who have instituted experiments on themselves, have both contributed something to our knowledge. It appears that these sensations are not always the same; and the difference probably depends on the various degrees in which the windpipe and blood-vessels are compressed. Some have retained no recollection of what happened to them; others were conscious of sudden loss of sense and motion; in others a deep sleep was

ushered in by flashes of light, by a bluish flame, by brilliant circles of colours, or by more definite ocular illusions, accompanied by hissing or singing in the ears. In other instances the sensations are stated to have been extremely pleasurable, though of short duration. These sensations resemble those that occur in cases of disordered cerebral circulation, and those that usher in the fits in some cases of epilepsy.

But it is only in cases of suicide that these pleasurable sensations manifest themselves. In homicidal cases, when much violence is used, the countenance expresses suffering; the eyes are brilliant and staring, and seem to be bursting from their sockets; and the eyelids open and injected; the tongue, swollen and livid, is forced against the teeth, or more or less protruded from the mouth, and compressed or torn by the contracted jaws; the lips are swollen and the mouth distorted; and blood, or a bloody froth, hangs about the mouth and nostrils; the upper extremities are stiff, the hands livid, and the fingers so forcibly closed on the palm as to force the nails into the flesh; and the convulsions are so violent as even to cause the expulsion of the contents of the bowels, and to produce erection of the penis, with expulsion of the urine, semen, or prostatic fluid. The circumscribed rosy or violet discolorations on the trunk and extremities common to all cases of death by apnœa are strongly developed; the course of the cord is distinctly indicated by a well marked bruise, or by some of the appearances presently to be described; and, on dissection, the muscles and ligaments of the windpipe are found stretched, bruised, or torn, and the inner coats of the carotid arteries sometimes divided.

The internal appearances are those of well-marked apnœa. The lungs are sometimes distended with air, sometimes collapsed.

Two principal medico-legal questions arise in regard to persons found hanged. 1. Did the suspension take place during life, or after death? and, 2, Was the hanging accidental, suicidal, or homicidal?

1. *Did the suspension take place during life, or after death?*

The points most worthy of attention as bearing on the solution of this question are:—*The mark of the cord; The appearance of the countenance; The position and state of the tongue; The condition of the genital organs;* and *The expulsion of the fæces.*

The Mark of the Cord.—The appearances on the neck due to suspension during life are by no means uniform. In homicidal cases, involving strong struggles, the neck sustains great injury, marked by the bruised skin, and the torn state of the subjacent parts; but in judicial and suicidal hanging much less injury is done both to the surface and to the deeper-seated parts.

In those cases (both judicial and suicidal), in which the position of the cord is mainly determined by the weight of the body, it follows pretty closely the line of the jaw-bone, and there is an oblique indented mark, of the colour of a recent bruise, on the fore part of the neck, and yellowish brown, as if from a singe, towards the angle of the jaw. The bruise may correspond with the whole breadth of the ligature; or there may be a deep groove, bordered by two discoloured lines. The mark varies with the size and texture of the cord, being less distinct when a soft material, such as a handkerchief, is used, than when a hard ligature, such as a rope, is employed. When the material is hard and resisting, the number of times that the ligature has been passed round the neck, and the material of which it consists, are clearly displayed. But in many cases of judicial and suicidal hanging, the mark of the rope consists at first of a simple depression without any change of colour, oblique if due to the weight of the body, horizontal if firmly fixed round the neck. After the lapse of several hours, the rope-mark assumes a light-brownish tint, and if an incision be made into the skin the cellular membrane is found strongly compressed, so as to form a shining white band. Sometimes the pressure is not equal on the two sides, or the back of the neck escapes. Sometimes, also, the pressure is lessened by the beard. The countenance, as will be presently more fully stated, is at first pale and its expression natural, and it is not till several hours have elapsed that it assumes a livid tint, and still longer before it wears a bloated appearance.

In a case of judicial hanging, in which the cord was removed soon after the body had been cut down, we observed merely a depressed circle on the fore part of the neck, and a slight excoriation, with a burnt appearance over the angle of the jaw. In a case of suicidal hanging with a small rope tied firmly round the neck, which was removed without delay, there was a white depressed line deeper at the back of the neck than in front and assuming a dusky hue after the lapse of several hours. The strands of the rope were distinctly marked, but there was no ecchymosis on any part of the neck. In another case of suicidal hanging a hard depressed chocolate-coloured band completely surrounded the neck, and corresponded to the rope of coir which had been used.

The appearances, then, produced by the cord in cases of hanging during life are not always the same: in some cases there is a well-marked bruise or ecchymosis, in others an indentation without discoloration, and a condensed state of the subcutaneous tissues, resembling old parchment; in others, again, a hard de-

pressed chocolate-coloured line; and these marks limited to the fore part of the neck, may be combined at the angle of the jaw with a singed appearance. The cuticle may also be abraded here and there.

The question, whether *the appearances occasioned by the cord during life can be produced after death?* has been answered in the affirmative. In the chapter on Wounds and Mechanical Injuries, it will be shown that bruises may be produced for some time after life is extinct; and that which is true of bruises in general will of course hold good with respect to this particular form of bruise. Accordingly Orfila proved, by experiments on the dead body, that, up to eighteen hours after death, precisely the same appearances may be produced as in suspension during life; Devergie has produced the parchment-like condition of the skin and subjacent cellular tissue, as well as the ecchymosed appearance bounding the depression; and Casper sums up the results of a long series of experiments by the remarkable statement "that any ligature with which any body may be suspended or strangled, not only within a few hours, but even days after death, especially if the body be forcibly pulled downwards, may produce a mark precisely similar to that which is observed in most of those hanged while alive;" and he adds that he has been convinced by his experiments that *the mark of the cord is a purely cadaveric phenomenon.* (Handbook, vol. ii. p. 173.)

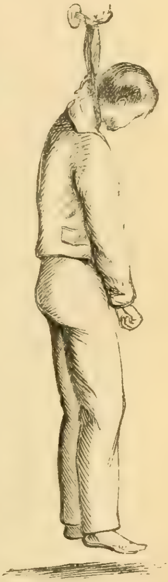
But for these confident statements of Casper, based upon

Fig. 31.

several experin ents and large experience I should have attached some value to the dark depressed chocolate-coloured line which

I encountered in one case of suicide, accompanied by so condensed a condition of skin that, when cut, it resembled closely the hardest and toughest brawn. The appearance of the neck is well shown in the engraving (fig. 31) taken from a photograph, which also displays the results of an experiment made with the same cord that was used in the suspension. This was fastened tightly round the neck within an hour of the death and left for about 20 hours. The result was a slightly depressed mark of the size of the cord, showing the projecting strands in white depressions, the rest in faint rose-coloured lines. This mark did not deepen in colour by exposure. The only other appearance worthy of note was the deep indigo blue colour of the ears.

Fig. 32.



The suicide had attached a neckerchief to a hook, and through the loop he had passed a small rope of coir, by which he suspended himself. He had climbed on to a table which he kicked from under him. His feet nearly touched the floor of the cell. (Fig. 32.)

But even in those cases in which the mark of the cord is less distinct and not in itself conclusive, an examination of the parts beneath the skin may enable us to speak with confidence. A considerable effusion of blood, a rupture of the trachea, a separation of its cartilages, a dislocation of the spine, a division of the coats of the vessels, or, indeed, any evidence of great violence, would furnish a strong probability of suspension during life, or of suspension after forcible strangulation.

State of the Countenance.—In death by hanging, whether judicial or suicidal, the countenance is usually pale, and the expression natural. But this pallor of the face is followed, after a few hours, by a livid hue of the lips, eyelids, ears, and face generally; and, after a still longer interval, by a marked congestion of the countenance. There is nothing in the expression or colour of the face to show that suspension took place during life or after death; but if the vessels of the head and face are found highly congested in a body recently cut down, there is a probability of

suspension during life; for suspension after death, though it might produce discoloration of the neck, could not cause turgescence of the vessels of the head and face.

Position and State of the Tongue.—The same injected and swollen state of the base of the tongue, with or without protrusion, which occurs in other forms of death by apnœa, occurs also in death by hanging, and affords a strong probability of suspension during life.

State of the Genital Organs.—The genital organs of both sexes are affected in death by hanging. In the female, redness of the labia and discharge of blood have been occasionally noted, and in the male a more or less complete state of erection of the penis, with discharge of urine, of mucus, or of the prostatic fluid, is present in at least one case in three. There may also be discharge from the urethra without erection. But it must be borne in mind, that these appearances in the genital organs, when they do occur, are not characteristic of death by hanging or strangulation, for they have been observed in other forms of violent and sudden death, as in fatal gun-shot wounds of the brain, and of the large vessels, and in poisoning by prussic acid.

This sign then, when present, is of considerable importance, for it is strictly vital, and affords a sure proof of violent and sudden death; and if combined with characteristic external signs and internal appearances, of death by hanging. On the other hand, the absence of erection and emission is no evidence that death was not due to this cause.

Expulsion of the Fæces.—This happens in about one fourth of the cases of death by hanging; but as it also occurs in other forms of sudden or violent death, it needs to be confirmed by characteristic appearances, external and internal.

2. *Accident, Suicide, or Homicide.*—Accidental hanging is very rare. One case is given by Dr. Smith:—It was that of a girl who was swinging in a brewhouse, and near the rope used by her for that purpose was another for drawing up slaughtered sheep. In the course of the exercise her head got through a noose of this second rope, by which she was pulled out of the swing, and kept suspended at a considerable height, until she died. Dr. Taylor also relates a case communicated to him by one of his pupils:—A boy ten years old had been amusing himself by fastening a piece of plaid gown to a loop in a cord suspended from a beam in the room. In the act of swinging he raised and turned himself, when the loop of rope suddenly caught him under the chin, and suspended him until life was extinct. A playmate witnessed the occurrence.

With the exception of a few cases of this class, in which the mode of death is obvious, the question under consideration is narrowed to this: *Was the hanging suicidal or homicidal?* The figures of the Registrar-General show that the probability is always strongly in favour of suicide; and, for obvious reasons, hanging is a mode of death which a murderer is little likely to resort to. It presupposes a great disproportion of strength between the murderer and his victim, or a combination of two or more persons against one. The solitary ascertained case of homicide in the five years 1852 to 1856, was committed on a young child.

There would be nothing in the appearance of the body itself, beyond the marks of a severe struggle, to distinguish the homicidal from the suicidal act; but if a man were found suspended at a height from the ground which he could not by any possibility have reached, and with no object near on which he could have mounted, we must conclude that he was suspended by another.

It was once supposed that a man found with the feet or some part of the body touching the ground was more likely to have been hanged by another than by himself; but careful observation has shown this to be an error, for suicides have been found, not only with the feet touching the ground, as in fig. 32, p. 275, but with the knees bent and raised from the ground, or in such postures that death must have been produced by leaning forcibly forward so as to compress the windpipe.*

As in most of the cases in which the body touches the ground the cord would not be so put on the stretch as to give it its usual oblique position, there would be no difference between such cases and cases of strangulation, except, perhaps, that in the latter the mark would be more distinct, and would embrace a greater portion of the neck.

The marks of violent struggles on the clothes or person of the deceased, or of severe injuries, would justify a suspicion of homicide; but as severe and extensive injuries have been known to be produced by a suicide, and slighter injuries may take place accidentally, this criterion must be used with caution.

It may be well to add that persons found suspended have been previously killed by strangulation or by other violence, or by poison.

* A great many cases, in which the bodies of suicides were found placed in every possible attitude, are given, illustrated by engravings, in an interesting paper in the fifth volume of the 'Annales d'Hygiène.'

DEATH BY STRANGULATION.

This mode of death is rare compared with death by hanging. It accounts for 50 deaths in the year, of which 37 in males and 13 in females. Only half of these deaths were ascertained to be suicidal; of which 20 in males and 5 in females. Homicide by strangulation, though much more common than by suspension, is rare in adults, but common in children.

Death by strangulation differs from death by hanging only in the fact that the body is not suspended; but some of the cases of suicidal hanging in which the body touches the ground might with equal propriety be set down to strangulation.

Strangulation may be effected either by the uniform pressure of a ligature round the neck, or by direct pressure on the windpipe. In rare instances the two are combined, some hard substance being introduced into the folds of the ligature, and placed over the windpipe.

From this distinction between death by hanging and death by strangulation, it follows that, as a general rule, the mark on the neck will differ in the two cases, being oblique and high in the neck in death by hanging, circular and low down in death by strangulation. From this general rule, however, those cases of hanging must be excepted in which the cord is firmly fixed, and those in which the body touches the ground; and those rare cases of strangulation in which the ligature happens to be fixed somewhat obliquely. The mark in hanging, therefore, may happen to be circular, and that in strangulation more or less oblique. The introduction of a foreign body into the folds of the ligature would be indicated by the greater size and distinctness of the bruise over the windpipe.

Another difference between strangulation and hanging is, that in strangulation much more force is used; hence the mark on the neck will be more distinct, and the injury to the subjacent parts greater; and this will be especially the case in homicidal strangulation, for the murderer generally uses unnecessary violence.

The same questions arise in respect of strangulation, as of hanging—viz., 1. *Was death caused by strangulation?* 2. *Was the strangulation accidental, suicidal, or homicidal?*

1. *Was death caused by Strangulation?*—A cord applied a few hours after death would not produce that amount of bruise which would result from its application during life; and the turgescence of the countenance, as well as the characteristic post-mortem appearances, would be wanting. It is only, therefore, in suicides, and in the scarcely conceivable case of slight force being used by

the murderer, or death taking place suddenly, from shock or syncope, that the appearances produced by a cord applied during life could resemble those due to its application after death. The same observations apply to direct pressure on the windpipe. As, moreover, hanging is known to be the more common suicidal act, the murderer is not likely to hide the real mode of death by simulated strangulation. It is much more probable that having strangled his victim, he would try to conceal the real mode of death, by suspending the body or placing it in a position suggestive of suicide.

In the well-known case of Bartholomew Pourpre, the deceased was first strangled and then suspended, and the mark of the cord was found at the lower part of the neck, while the teeth knocked in, and the bloody mouth, showed the violence that had been used.

The murderers of Sir Edmondbury Godfrey, after strangling him near Somerset House with a twisted handkerchief applied with great force, concealed the body for a time, and then carried it to Islington, threw it into a ditch, passed his own sword through him, and laid his gloves and other articles of dress on the bank, so as to create the belief that he had committed suicide. The absence of blood from the wound, though the sword had passed through the heart, excited suspicion, which was fully confirmed by the discovery of a bruise, an inch broad, extending round the neck, and a fracture of the cervical vertebræ, which rendered the neck so flexible that it could be turned from one shoulder to the other. The face, which during life was remarkably pale, was livid and suffused, and the eyes bloodshot.

2. *Accident, Suicide, or Homicide.*—That strangulation, like hanging, may be accidental, is proved by the following cases:—

An ingenious young man having nearly lost the use of his arms was in the habit of moving a heavy weight by a cord attached to it and passed round his neck. One morning, shortly after having retired to his room, his sister found him sitting in a chair quite dead, with the cord twisted round his neck. The deceased must have attempted to move the weight in the usual way, but it had slipped behind, had compressed the trachea, and so strangled him. (Dr. Smith.)

In July, 1839, Elizabeth Kenchan, an extremely dissipated, drunken, and disorderly woman, went to bed intoxicated, with her bonnet on, and in the morning was found strangled in its strings. She had fallen out of bed, her bonnet became fixed between the bedstead and the wall, and she, being too drunk to loosen the strings, was strangled.

In a few cases, then, death by strangulation has been due to accident; but if we have convinced ourselves that death did not

take place in this way, the question is narrowed to the alternative of—

Suicide, or Homicide.—Strangulation appears to be a suicidal act in about half the recorded cases. As it is difficult for a man to strangle himself by the pressure of his hands even with the aid of a ligature, some mechanical contrivance is usually resorted to. In one case (Orfila), two cravats were twisted several times round the neck; in another (Dunlop), a Malay used a small stick for the same purpose; in a third case, the handle of a pot was used. In the year 1838 a Mr. Watson, aged 88, strangled himself by placing a poker through the tie of his neckerchief and twisting it round and round.

Strangulation by pressure of the hand on the trachea (throttling) may be safely assumed to be homicidal, as in the following case. A robust man, on some slight provocation, seized another by the cravat, and pressed him firmly against a wall till he was dead. On examining the body, the face was found livid and swollen, and the features distorted. There was also considerable discoloration and depression on that part of the neck to which the pressure had been applied. There were witnesses to the act, and the man was proved to be insane. (Case at the Chester Assizes, April, 1835.)

An unsuccessful attempt to attribute death to accidental throttling was made in 1763, in the well-known case of Beddingfield.

He was found dead in his bed-room, and his wife and manservant were charged with the murder. The medical testimony was very unsatisfactory, as no dissection had taken place, but it was proved that there were marks on the neck resembling those of fingers. One surgeon said there were marks of a thumb and *three* fingers; the other of a thumb and *four fingers;* while another witness saw only *two,* "which looked as if the blood was set in the skin." The deceased was found lying on his face on the floor, with one hand round his neck. One of the criminals after condemnation confessed that he had strangled Beddingfield in his sleep, by seizing his throat with his left hand; and that though he struggled violently and made some noise, he soon accomplished his purpose.

The appearances caused by throttling, when great resistance is offered, may be inferred from the evidence of Mr. W. Wilson in the case of Hector M'Donald, convicted of the murder of his wife, at Inverary, April, 1857. There was an abrasion on each side of the windpipe, five abrasions on the left, and three on the right arm; and the skin on the front and sides of the neck, and on the upper part of the chest, was blackened. On the throat

were the marks of a thumb and three fingers. It was inferred that the throat had been grasped by the left hand, of which the wrist was pressed upon the chest, and that the right hand had grasped the left arm of the victim. The internal appearances were highly characteristic of death by apnœa. The substance and membranes of the brain were injected; the right side of the heart contained a quantity of dark fluid blood; the left was nearly empty. The lungs also contained a quantity of dark fluid blood. All the internal viscera were healthy.

The following is a case of homicidal strangulation by a foreign body introduced into the ligature:—Dr. Clench, a London physician, was called out of bed by two men on the night of the 4th of January, 1692, to visit a sick friend. He entered a hackney coach with them, and drove about several streets in the City for an hour and a quarter. The men then left the coach, and sent the driver on an errand. When he returned, he found Dr. Clench sitting on the bottom of the coach, with his head on the cushion of the front seat. Thinking him in liquor, he shook him, but obtained no answer. He then called the watch, and they found him strangled by a coal wrapped in a handkerchief, and applied directly over the windpipe. The coachman had heard no noise while driving the carriage.

DEATH BY SUFFOCATION.

Under this head are comprised all cases of apnœa, not produced by direct pressure on the windpipe, with the exception of drowning, which has already been treated separately.

On an average of the five years 1852 to 1856, 708 deaths by suffocation occurred, of which 427 in males, and 281 in females. Of the whole number, 106 were infants killed by overlying, and about 180, also infants, were suffocated by bed-clothes; 57, of whom the majority were young children, were suffocated by their food, 38 by gases, chiefly carbonic acid. Two suicides, five murders, and one manslaughter by suffocation are reported to have happened annually.

Suffocation may take place in many ways.

1. *The mouth and nostrils may be stopped* by accident or by force. A person in a state of helplessness, from whatever cause, may fall on the face and be suffocated by water or loose earth; and new-born children by the discharges, by the bed-clothes, or by being overlaid in bed. Murderers have also despatched their victims by this means.

2. *Mechanical Pressure on the Chest.*—This may occur from

accident, as when a quantity of earth or rubbish falls upon a man; or as a homicidal act, combined with strangulation, the murderer pressing with his whole weight on the body, and compressing the windpipe with the hand; or compressing the chest and closing the mouth and nostrils. Suffocation by pressure on the chest constituted part of the *peine forte et dure* of our ancient law. A risk of accidental suffocation by pressure on the chest has sometimes been incurred in taking casts with plaster of Paris.

On the 14th of June, 1837, no less than twenty-three persons lost their lives at the Champs de Mars by pressure in a crowd, death being due partly to suffocation and partly to severe injury to the chest.

3. *Closure of the Glottis.*—This also may occur accidentally, as in the 57 cases mentioned above of suffocation by food. When this happens in adults they are usually intoxicated, or in a fit. Thus Paris and Fonblanque quote the case of a patient who died in an epileptic fit after a heavy meal of pork. The trachea contained a quantity of matter, resembling the pork on which he had recently dined. Suffocation by food is not an uncommon termination of the general paralysis of the insane.

Among familiar examples of accidental suffocation may be cited the death of Anacreon, attributed to a grape-seed; and of Gilbert the poet to a piece of mutton. There is a case on record of suffocation from swallowing a bee in some honey; and another from slaked lime getting into the larynx. Such small bodies as a piece of potato-peel have been found impacted in the rima glottidis, and small morbid growths, and the products of inflammation have often sufficed to close this narrow passage.

Suffocation has also been often threatened and sometimes brought about by bodies impacted in the upper part of the gullet. Thus slaves, both in ancient and modern times, are alleged to have swallowed their tongues. In other instances, some article of dress, such as a handkerchief, has been swallowed, and one determined suicide caused a fatal hæmorrhage by swallowing a cork bristling with sharp pins. The preparation is in the museum of King's College.

Suicidal suffocation by the vapours of charcoal are not common in England but very frequent in France.

Suffocation is not a mode of death often resorted to by murderers, in the case, at least, of young and vigorous adults; for the force required is such as to reveal the cause of death by external marks and internal appearances; but when the body is very weak from any cause, as in the new-born infant, the old

man, or the intoxicated, suffocation is not very difficult to effect, and, if not attended by great violence, might not betray itself by the state of the body externally or internally.

The post-mortem appearances present in well-marked cases of death by suffocation may be inferred from the account given by Dr. Ollivier of the suffocated in the Champs de Mars. In the twenty-three persons, without exception, the skin of the face and neck was of a uniform violet tint, spotted with blackish ecchymoses. In nine, the eyes were bloodshot; in four, a bloody froth ran from the mouth and nostrils; in four, blood ran from the nostrils; in three, blood flowed from the ears; in seven, there were fractures of the ribs; in two, females, fracture of the sternum. In sixteen bodies that were opened, the blood was black and fluid, and filled all the large veins at the right side of the heart. The pulmonary tissue was mostly of a reddish brown, and in three quarters of each lung, posteriorly, there was a considerable accumulation of black and liquid blood; but there was no ecchymosis, either on the surface or in the substance of the lungs, except in one case. In all the cases in which the eyes were bloodshot, and in those in which blood flowed from the ears, the vessels of the pia mater and substance of the brain were gorged.

From the slight injuries caused by the suffocation of helpless people, this mode of death was, previous to the passing of the Anatomy Act, selected by the murderers Burke and Bishop. Burke, with his female accomplice, Macdougall, was tried at Edinburgh in 1828, and Bishop, with Williams and May, in London, in 1831.

Burke destroyed the deceased, Margery Campbell, by sitting on her body, covering her mouth and nostrils with one hand, and applying the other forcibly under the chin.

Fifty-nine hours after death, the eyes were closed; the features composed, as in deep sleep, red, and somewhat swollen; the lips of a dark colour; and the eyes bloodshot. There was a little fluid blood on the left cheek, apparently from the nostrils; the tongue was not protruded or torn by the teeth, but there was a slight laceration on the inside of the upper lip opposite the left eye-tooth; the cuticle under the chin was much ruffled, and the surface of the true skin, when laid bare, was dry and brown; but there was no bruise. The integuments, except on the face, were perfectly free from lividity. The joints were flaccid. There was no effusion of blood or laceration of the parts around the windpipe, and no injury of the cartilages, but the os hyoides and thyroid cartilage were further apart than usual, in conse-

quence of the stretching of the interposed ligament. The following were the internal appearances: The membrane of the windpipe healthy, with here and there some tough mucus, not frothy, and a few points of blood between it and the membrane. The organs within the chest perfectly natural; the lungs remarkably so. The blood throughout the body was black and fluid, and accumulated in the large veins, and in the right cavities of the heart. The abdominal viscera, with the exception of incipient disease of the liver, were healthy. The brain also was quite healthy, and presented a little more turgescence than usual; and there were three extravasations of blood in the scalp, but without corresponding external bruise. There were some marks of violence on the limbs, considerable effusions of blood among the muscles of the neck, back, and loins, and on the sheath of the spinal cord. The posterior ligamentous connections between the third and fourth cervical vertebræ were torn. These injuries to the back were shown to have been occasioned after death by the forcible doubling up of the body. It should be added that a "handful" of clotted blood was found near the body.

In the case of Carlo Ferrari, the victim of Bishop and Williams, the appearances from which suffocation might have been inferred were even less strongly marked. The face, it is true, was swollen and congested; the eyes bloodshot, and the lips tumid; but the lungs were quite healthy and not congested, the heart was contracted, and all its cavities quite empty. But these exceptional appearances were explained, by the fact, that the murderers, after stupefying their victim with liquor, lowered his body into a well with the head downwards, taking care to keep the mouth below the water. In this case, too, there was some extravasated blood under the scalp, among the muscles of the neck, and on the spinal cord. The fresh state of the body, the appearance of the countenance, and a wound upon the left temple, combined to excite suspicion, and led to the committal and conviction of the murderers.

In both these cases death was certainly caused by suffocation, and yet the appearance of the bodies was not such as to lead at once to the conclusion that death had happened in this way. The medical examiners, in both cases, were inclined to ascribe the deaths to the injury done to the spine, which was afterwards proved to have been occasioned after death by the forcible doubling up of the bodies in packing them.

In allusion to the opinion expressed by some medical men, that the signs of suffocation are so strongly marked as of themselves to arrest attention, Dr. Christison observes:—"In the body of

the woman Campbell, no person of skill, whose attention was pointedly excited by being told that from general circumstances murder was probable, but the manner of death unknown, could have failed to remark signs that would raise a suspicion of suffocation. But if his attention had not been roused; if, for example, he had examined it in the anatomical theatre of an hospital, without knowing that suspicions from general circumstances were entertained regarding it, he might have inspected it even minutely, and yet neglected the appearances in question. Nay, a person of skill and experience would have been more likely to do so than another, because every one who is conversant with pathological anatomy must be familiar with such or similar appearances, as arising from various natural diseases." Dr. Christison then draws attention to the close resemblance between the appearances present in the body of Campbell and those observed in the body of a man who died of dysentery, adding that the "vascularity of the conjunctivæ and the contusions on the legs made the only difference."*

* Cases and Observations in Medical Jurisprudence: 'Ed. Med. and Surg. Journal,' vol. xxxi. 243. (1829.)

CHAPTER III.

WOUNDS AND MECHANICAL INJURIES.

In this Chapter it is proposed to treat of all injuries inflicted by mechanical means, except the several forms of death by suffocation treated of in previous chapters, and injuries by fire, and by lightning, reserved for separate examination in succeeding ones.

All injuries, therefore, which one man inflicts upon another, whether by cutting or bruising instruments, by his own person, or by forcing him against an obstacle, will have to be considered under this head. For the punishment of all such injuries when maliciously inflicted, the statute law makes provision, no less than for stabbing, cutting, shooting, drowning, strangling, and suffocating, by the insertion of the words "or shall by any means whatsoever wound or cause any grievous bodily harm to any person," and "by any means other than those specified," &c., and "with or without any weapon or instrument," &c. (§§ 11, 15, and 20, of 24 and 25 Vict. cap. c.)

In examining so large a subject, methodical arrangement is especially necessary. The different kinds of mechanical injury will have to be separately considered, the questions common to all such injuries must be discussed, and the peculiar way in which they affect the more important organs of the body must receive due attention.

Three kinds of mechanical injury will have to be separately examined:—wounds in the common acceptation of the term, gunshot wounds, and mechanical injuries not usually designated as "wounds."

The old surgical definition of a *wound** makes it to consist in a *solution* of *continuity*. Mechanical injuries, therefore, may be conveniently divided into such as are *without solution of continuity* and such as are *with solution of continuity*. The first will include, *contusions*, *concussions*, *simple fractures*, *dislocations*, and

* "A wound is a solution of continuity in any part of the body suddenly made, by anything that cuts or tears, with a division of the skin." "By the word skin, I understand not only the external cutis, but also the inward membranes of the gullet, ventricle, guts, bladder, urethra, and womb, all of which are capable of wounds from sharp instruments, either swallowed or thrust into them."—Richard Wiseman's 'Chirurgical Treatises,' book v. chap. i.

sprains. The second comprises *incisions, punctures,* and *lacerations, compound fractures,* and *gun-shot wounds.*

Each class of injuries, whatever the parts affected, has some points common to all the forms of violence included in the class. Thus, almost all injuries affecting the deeper-seated parts of the body are accompanied by external traces of the force which produced them, whether it caused a solution of continuity or not. So that in most cases we shall have traces of the injury on the *surface,* and it will therefore be necessary to examine minutely the subject of bruises and incisions involving the external parts of the body.

The most convenient arrangement has now been sufficiently indicated. The subject will be best examined under the following heads:—1. The characters of contused wounds, and of injuries unaccompanied by solution of continuity. 2. The characters of incised wounds, and of those accompanied by solution of continuity. 3. The characters of gun-shot wounds. 4. The questions common to all forms of mechanical injury. 5. Wounds as they affect the several important organs of the economy. 6. The detection of blood-stains on clothes, weapons, &c.

I. CONTUSED WOUNDS, AND INJURIES UNACCOMPANIED BY SOLUTION OF CONTINUITY.

A blow with a blunt instrument causes an appearance on the surface commonly known as a bruise, and, in scientific language, as an *ecchymosis.* It consists in a discoloration of the skin produced by extravasation of blood into the cellular membrane. This may take place in the superficial or in the deep-seated parts. When it happens in the superficial parts, and especially in the lax and yielding portions of the skin, the colour makes its appearance at once. When deeper seated, days may elapse before the skin becomes discoloured, and then it is not blue, as in superficial parts, but of a violet, greenish, or yellowish hue; nor is it always immediately over the extravasation.

The colour is not fully developed at once; but it continues to deepen for five or six hours. When blood ceases to flow from the broken vessels, serum is effused, and inflammation is set up, and thus the bruise is enlarged. Its colour also undergoes a change, passing from deep blue through shades of green, yellow, and lemon colour. After a further interval, the effused fluids are absorbed, and the colours first fade and then wholly disappear.

If the parts have received great injury, the inflammation runs on to suppuration, forming an abscess if the injury is deep, an

ulcer if superficial. The change of colour begins at the circumference, where the effused fluids are scanty, and travels inwards towards the centre, where they are abundant, and where the deep blue colour often remains after the rest of the bruise has completely changed its appearance. In bruises of any extent, and in parts which contain much blood, coagula are formed.

The extent of the bruise, and the rapidity of its changes, will depend on the force used, the size and character of the weapon, the age and constitution of the sufferer, the full or empty state of the vessels, and the tension or laxity of the skin.

As the form of a bruise is mainly determined by the shape of the weapon, it often furnishes strong presumptive evidence. Thus Starkie, in his 'Law of Evidence,' relates a case in which a blow on the face given in self-defence, with the key of the house-door, caused a bruise which corresponded in shape to the wards of the key, and served to identify the man who had committed the assault. The subjects of death by hanging, strangulation, and suffocation, furnish good examples of this correspondence of bruises with the cause that produced them.

The discolorations which constitute a bruise are not confined to the cellular membrane, but involve more or less the substance of the true skin. Bruises are thus distinguished from cadaveric lividity. (See p. 238.) The amount of injury, and consequent extent of bruise, will also depend, as just stated, on the condition of the parts involved. A boxer in training would scarcely be marked by a blow that would disfigure a person in ordinary health; and in severe cases of scurvy the slightest touch causes a bruise closely resembling that produced in healthy persons by greater violence.

But blows, even when very severe, do not produce marks of injury on the surface, if the parts beneath are soft and yielding. Thus blows on the abdomen, severe enough to rupture the viscera, do not always bruise the skin, though they sometimes lead to the effusion of blood between the muscles. On the other hand, when severe injuries of hard parts, such as fractures of bone, are unattended by a bruise, there is a strong presumption against their having been caused by a blow.

Can the appearance of a Bruise be produced after Death?

This question is answered by the experiments of Christison, from which it appears, that, up to two hours after death, and, in rare cases, after three hours and a quarter, appearances may be produced more or less closely resembling bruises inflicted during life; blood is effused into the cellular membrane, on the surface of the cutis, and even into its substance; and the blood thus effused is found to coagulate.

Distinction between Bruises inflicted during Life and after Death.—In certain cases this distinction is easy. If there is much swelling, any change of colour, or any sign of inflammation, the bruise must have been inflicted during life.

If on cutting into the bruise, the effusion of blood is found to be considerable, and the clots large, the presumption is strongly in favour of its having been inflicted during life. So also if the cutis is discoloured from the effusion of blood into its texture. This last is a valuable diagnostic mark, except in the case of bruises inflicted a few minutes after death, when, judging from the analogy of incised wounds, we may expect the same appearances as in those produced during life.

As the same effusion of blood, which, on the surface, gives rise to the appearance of a bruise, may, when it occurs in the deeper seated parts leave little or no trace on the surface, it is important to ascertain whether such deeper effusions of blood may take place after death as well as during life. This question may be safely answered in the affirmative. In the body of Margery Campbell, the victim of Burke, there were marks of severe injury to the back, to which Dr. Christison was at first inclined to attribute her death; and semi-fluid blood was found under the trapezius muscle, near the inferior angle of the scapula, and in the cervical, dorsal, and left lumbar regions, especially in the former, but there was no corresponding bruise on the skin. The posterior ligaments of the vertebræ were ruptured, but there was no fracture. On the sheath of the spinal cord opposite the rupture, there was a mass of semi-fluid black blood an inch in diameter, and about the thickness of a penny; from this a thin layer of blood extended along the posterior surface of the sheath, as far as the lowest dorsal vertebra. The spinal cord was uninjured, and there was no blood under its sheath. Dr. Christison proved that all these marks of violence might be produced seventeen hours after death, by bending the head forcibly down upon the chest. In the body of Carlo Ferrari, also, five or six ounces of coagulated blood were found among the deep-seated muscles of the neck, from the occiput to the last cervical vertebra; and there was a large quantity of fluid blood in the upper and lower part of the spinal canal, exterior to the sheath of the cord, but there was no blood within the sheath, nor had the vertebræ, or their ligaments, or the cord itself, suffered any injury. The confession of the criminals showed that these injuries to the spine were produced after death. (Refer to p. 283.)

The difficulty of determining whether a bruise was inflicted during life or soon after death, will be greatly increased if putre-

faction has set in; for the effect of putrefaction is to exaggerate the appearance of injury, and to produce great alterations of consistence and colour, while the pressure of the gases evolved in the putrefactive process may cause copious outpourings of blood through ruptured vessels. This was well shown in the body of a man who had died of apoplexy. The veins of both arms had been opened, but no blood had flowed during life. After death, however, an abundant outpouring of blood took place from the wounded vessels.

In a case which occurred at Paris, the effusion of blood caused by strangulation was discovered as a black mass twenty years after death. But the cord was found round the neck, and removed the difficulty which might otherwise have existed.

In respect to *fractures* the same observations apply, and in nearly the same degree. There is every reason to believe that a fracture produced within a short period after death, and one produced during life, but speedily followed by death, would present very nearly the same appearances. A fracture caused some time before death would be readily distinguished by the inflammation set up about it.

Fractures may be detected long after death. Thus, in the body of Clarke, the victim of Eugene Aram, the fracture and indentation of the temporal bone were plainly distinguished after the lapse of thirteen years.

II. INCISED WOUNDS, AND WOUNDS ACCOMPANIED BY A SOLUTION OF CONTINUITY.

Under this head are comprised incised, punctured, and lacerated wounds. Gun-shot wounds will be treated of separately. It is to incised wounds that the following observations chiefly apply.

The immediate obvious consequences of wounds with solution of continuity are hæmorrhage, and retraction of their edges: the remote effects are those of inflammation and its sequelæ. In a recent incised wound, inflicted during life, there is copious hæmorrhage, the cellular tissue is filled with blood, there are coagula between the lips of the wound, and the edges are everted. After the lapse of from eighteen to twenty-four hours there are the signs of inflammation, increased redness, swelling, and effusion of coagulable lymph.

Copious hæmorrhage affords of itself a strong presumption in favour of a wound having been inflicted during life, especially if the body is fresh. Scanty hæmorrhage, or the entire absence of it, as in the case of Sir Edmondbury Godfrey (p. 279), supplies

an equally strong reason for attributing death to some other cause. But lacerated and severe gun-shot wounds form an exception to this rule. In the well-known instance recorded by Cheselden of a man's arm torn off by a windmill, and in a case more recently reported by Mr. Bransby Cooper, there was scarcely any hæmorrhage. On the other hand, very considerable hæmorrhage may take place after death, and especially when putrefaction is set up, if any large vein happen to be wounded.

In the case of incised, as of contused wounds, it is important to determine whether the appearances found in wounds inflicted during life may be produced after death.

Characters of Wounds produced after Death.—The experiments of Orfila on the dog have shown, that the appearances proper to incised wounds inflicted during life may be produced immediately after death; and the experiments of Dr. Taylor made on limbs recently amputated, show to what degree the resemblance may be carried.

When the incision was made ten minutes after the removal, there was immediate considerable retraction of the skin, protrusion of the adipose substance, and scanty flow of blood; and after twenty-four hours, the edges were found red, bloody, and everted; the skin somewhat flaccid; a small quantity of blood escaped on separating the edges; no coagula adhered to the muscles; but at the bottom of the wound were several loose coagula.

After the same interval of ten minutes a second experiment was performed. The edges of the wound were slightly everted; scarcely any blood escaped; and twenty-four hours afterwards the edges were pale and perfectly collapsed, and at the bottom of the wound were a few coagula.

When the wound was not made till two or three hours after the removal, a small quantity of liquid blood was effused, and no clots were found. The edges of an incised wound made twenty-four hours after death were yielding, inelastic, in close approximation, and free from coagula.

Lacerated wounds combine the characters of incised and contused wounds, being accompanied with less hæmorrhage than the former, and less discoloration than the latter. The distinction between such wounds inflicted during life and after death is less easily made.

Punctured wounds are intermediate between incised and lacerated wounds, resembling the former when inflicted with a sharp instrument, and being often accompanied by profuse hæmorrhage; but when made with a blunt object, being more like lacerated wounds, and occasioning little loss of blood. *Sword-*

wounds traversing the body, have a large depressed orifice of entrance, and a small and raised orifice of exit.

III. GUN-SHOT WOUNDS.

These belong to the class of contused or lacerated wounds; of contused wounds when the shot does not penetrate, of lacerated wounds when it enters or traverses the body. They are, as Wiseman observes, "the most complicate sort of wounds;" they combine "contusion, attrition, and dilaceration" in a high degree; they occasion "all sorts of fractures;" they introduce extraneous bodies; and they give rise to hæmorrhage, inflammation, erysipelas, gangrene, and sphacelus. The lips of a gun-shot wound are "livid or blackish;" they become the seat of inflammation and swelling; and "blisters frequently rise about them," containing "matter of a fœtid smell."

Gun-shot wounds caused by discharges close to the person are "burnt by the flame," and they may contain particles of unconsumed powder. If covered by clothes, these also may be blackened or burnt. As a general rule gun-shot wounds, unless they injure some large vessel, do not give rise to much hæmorrhage; but the destruction of parts from the sloughing and suppuration that follow them often occasions profuse and fatal discharges of blood.

The bullet, shot, or wadding discharged from fire-arms at short distances sometimes lodges in the body, sometimes traverses it. When they lodge, they often furnish very conclusive evidence. The bullet may prove to have been cast in a mould, or the wadding to be formed by printed paper or other material, in the possession of the person who fired the shot. It may even happen that the composition of the bullet, or the mode of making it, is peculiar. In medico-legal cases, therefore, the contents of a gun-shot wound should be carefully examined, and preserved. When the bullets traverse the body, the two apertures should be carefully examined. The aperture of entrance is round and clean, that of exit less regular in shape and jagged. On entering the body "the bullet forces the flesh in with it, and the place by which it enters presently contracts closer; but its going out is more lax." The same difference of entrance and exit is seen in the clothes. Bullets that strike the body obliquely produce a valvular wound.

Bullets which lodge in the body are often found to have been turned out of their direct course by contact with a bone, or other firm resisting structure. Thus (to give examples from the practice of Richard Wiseman) a bullet entered the cheek and was cut

out from the back of the neck; a second, entered the outside of the small of the leg, and was found on the inside of the thigh above the knee; and a third entered the outside of the arm, and was cut out below the scapula. In some cases, the bullet has struck the head or abdomen, and after traversing the half-circumference of the part, has been found to be lodged, or to have passed out at, the opposite point. Again, bullets may be split into two or more fragments by striking a bone, and these fragments may either traverse the body or lodge in it. If they lodge, they may be found to have taken the same eccentric course as the undivided bullet in the cases just cited: if they traverse they may occasion more than one wound of exit resembling those caused by a single bullet.

When the bullet takes a direct course through the body (that is to say, when it is not deflected) the character of the two apertures, coupled with the direction of the line which joins them, may serve to indicate the position of the body at the time the wound was received. So also when a bullet, after traversing a wooden paling, or a window, strikes a wall beyond, the line of flight, and spot from which the shot was fired, may be determined.

Small shot discharged quite close to the body, and striking it at right angles, may cause a round clean wound not easily distinguished from one produced by a bullet; but at the distance of a foot or more the shot are found to scatter, and to occasion an irregular wound. At the distance of three feet the shot are so much scattered that it is not possible to confound the injury with one caused by a bullet. In these wounds some of the shot lodge in the body, and when fired close, or within a short distance, there will be marks of burning on the skin and clothing.

Fire-arms loaded with wadding, and fired close to the body, or within a few inches, may produce severe, and even fatal, penetrating wounds, and even at the distance of a foot may give rise to extensive superficial injuries. The unconsumed powder, when fire-arms loaded only with powder are discharged close to the body, may produce the same injuries as small shot.

From what has been said above of the complicated nature of gun-shot wounds, it is obvious that they are very dangerous to life. They may prove fatal, immediately, or within a short interval, by shock or hæmorrhage, and after a longer interval, by secondary hæmorrhage, by erysipelas, by tetanus, or by the inflammation and extensive suppuration following on the death of the injured parts.

The usual medico-legal questions, such as the more or less

dangerous character of the wound, the effect of the treatment adopted, and of the subsequent conduct of the wounded person, on the issue of the injury, and the amount of locomotion possible after it, arise in gun-shot as in other wounds.

The question whether the wound was the result of *accident*, *suicide*, or *homicide* may also be raised respecting these in common with other wounds. As a general rule, accidental wounds, whether inflicted by the wounded person, in loading, or in the act of carrying a loaded piece, or by another person pointing at him a piece supposed not to be loaded, or walking or shooting in his company, have the characters of wounds caused by discharges near the person; but these characters they have in common with suicidal wounds. But suicidal wounds have the character which accidental wounds often, and homicidal wounds sometimes, lack, of being inflicted in front on the head or region of the heart. To this rule, however, some suicidal gun-shot wounds form an exception, inasmuch as the weapon is directed to the back of the head. As a general rule, too, the suicide fires only one shot; but suicides have been known to fire two pistols, and even to resort to fire-arms after the failure of incised wounds. In some cases the suicide is found in a room secured from within, with the weapon still grasped in the hand, and, when the priming was of powder, with the hand stained by it.

Some advantage is occasionally derived from an examination of the gun or pistol. When the combustion of the powder is imperfect, the finger introduced into the barrel is blackened by the unconsumed charcoal; and the residue is found to consist of this unconsumed charcoal mixed with sulphide of potassium. But when the combustion is perfect the finger is not blackened, for the residue consists of the white sulphate and carbonate of potash. After an interval of some days, varying with the quantity of moisture in the atmosphere, the mixed residue of charcoal and sulphide of potassium becomes converted into sulphate, which after a still longer interval may be found blended with the rust of iron.

IV. QUESTIONS COMMON TO ALL FORMS OF MECHANICAL INJURY.

There are three questions common to all forms of mechanical injury:—1. *Was it inflicted during life?* 2. *Was it the cause of death?* and 3. *Was it accidental, suicidal, or homicidal?* The first question has been already examined; the second and third remain to be discussed.

Was the Wound the cause of Death?—The answer to this question rarely presents any difficulty when a man in the enjoy-

ment of perfect health receives a severe injury, and dies before sufficient time has elapsed for disease to set in, or neglect, or unskilful treatment to prove injurious. But when a considerable interval elapses between the receipt of the injury and the fatal event, such complications may arise, and render the answer to the question difficult.

To the first class of cases belong the abnormal formation of the parts injured (as in the instance of a boy caught robbing an orchard, whose death was caused by a blow intended as a simple chastisement, on a skull preternaturally thin), and their abnormal situation (as in the familiar instances of an inguinal hernia injured by a kick; of fatal hæmorrhage caused by a blow on the loins over the seat of a kidney containing a jagged calculus; and of a large abscess behind the ear ruptured by the same means).

To this class also belong those sudden deaths which follow falls or blows too slight to account for the fatal result by the direct injury they occasion, death being really caused by the rupture of a vessel on the brain, or of an aneurism; in both which cases it is possible to attribute the death to the excitement of the struggle as well as to the fall or blow. Also those cases of latent effusion on the brain or into the cavities of the chest which might prove suddenly fatal even in the absence of violence, but are very likely to cause death under the influence of excitement or shock.

In these cases the injury is inflicted in ignorance of the existence of any cause by which, though comparatively slight, it might be rendered mortal. To all other cases, such as those of young, feeble, or aged persons, and pregnant women, the English law, as laid down by Lord Hale, will apply: "it is sufficient to prove that the death of the party was *accelerated* by the malicious act of the prisoner, although the former laboured under a *mortal* disease at the time of the accident."

The second class, or that in which an interval elapses before the wound proves mortal, comprises a greater number of special cases. Before treating of these in detail, it is necessary to premise that even when the interval between the injury and the fatal result is considerable, it may be quite possible to attribute the death to the injury without any misgiving; for it may be such that no strength of constitution, and no care or skill, could avert a fatal termination. In fractures or dislocations of the spine, for instance, and in gun-shot wounds when the bullet lodges in the body, however long the fatal result may be postponed, the death is fairly attributable to the injury alone. But though, in cases of this kind, no doubt can exist either respecting the true cause of death, or the guilt attaching to the act of vio-

lence, the lapse of time has, in most civilized countries, been taken into account, and by the common law of England, if the injured party survive one year and one day, the crime ceases to be murder; and English juries have sometimes shown a disposition to shorten this period very considerably.

Within this period of 366 days there is ample opportunity for some of the circumstances now to be specified to come into play.

1. A trifling wound or injury may prove fatal, from the injured part taking on an unhealthy character, such as scrofulous inflammation, due to peculiarity of constitution, or erysipelatous inflammation from exposure to contagion.

2. To the same class of cases belong attacks of fatal tetanus, or of delirium tremens from slight injuries, as well as rare instances of pyæmia from latent abscess brought into activity by a fall or blow, and fatal diseases of internal organs arising independent of, but soon after, the injury.

3. Another circumstance bearing on the question, Was the wound the cause of death? is the improper management of the wounded party: whether consisting in the neglect of medical assistance, or of medical instructions; or in the resort to ignorant and unqualified practitioners; or in irregularities, misgovernment, and reckless exposure to cold, fatigue, or fresh injury, or to intoxication, on the part of the patient himself; or in *mala praxis* on the part of a qualified medical attendant.

Was the Wound Accidental, Suicidal, or Homicidal?—Accidental death is a common occurrence in crowds, and in wrestlings and fights, when the deceased person falls, or is thrown or struck against hard resisting objects, in which case an examination of the spot will help to determine the question.

There is always a probability of accident when a body is found in a dangerous situation, as at the foot of a precipice, or in a river with steep banks; and the probability is increased when the deceased is proved to have been drinking previously. In all doubtful cases the character of the injuries will go far to determine the class to which the death belongs. Bruises, fractures, and dislocations, for instance, are more consistent with the theory of death by accident than incised, punctured, or lacerated wounds.

If we suppose the alternative of accident to be excluded by the nature of the case, the original question is narrowed to this, *Was the wound suicidal or homicidal?*

As suicide is much more common than homicide, there is always a *primâ-facie* probability in favour of suicide, especially in middle-aged persons; but this probability will be materially

modified by such considerations as, the place in which the body is found; the nature, seat, extent, and direction of the wound; and the number of wounds.

Place where the Body is found.—The finding of a corpse in a room with the windows and doors fastened on the inside, is conclusive of suicide. The absence of the instrument of death is conclusive as to murder. So also, if the blood from a mortal wound has been washed from the body or floor, or the body itself has been placed in a position inconsistent with the mode of death, or covered, or buried.

Nature of the Wound.—*Contused wounds* are rarely suicidal, though attempts at self-destruction by knocking the head against the wall are not uncommon. Severe contusions, therefore, are most probably homicidal, unless the body is lying near a height from which it might have fallen, or from which the deceased might have thrown himself. *Incised wounds* are as likely to be suicidal as homicidal, and it is not easy to infer from the character of the wound to which class it belongs. The cleanness and evenness of an incised wound have, indeed, been thought to afford a probability in favour of homicide, but without sufficient reason; for a resolute suicide is more likely to have a steady hand than a murderer to meet with no resistance; and some of the deepest and cleanest wounds of the throat are certainly suicidal.

In a few instances the *shape* of an incised wound helps us to determine the question of suicide or homicide, by indicating the kind of instrument with which it was inflicted, and the occupation of the murderer. Thus, a man with his throat cut from within to without, as butchers slaughter sheep, was found to have been murdered by a butcher; and in the case of a body divided into two parts by a cutting instrument passed into the fibro-cartilage uniting the third and fourth lumbar vertebræ, so as to divide the articulating processes transversely, as butchers cut through the spines of animals, a butcher was proved to have been the murderer (Orfila).

Situation of the Wound.—It may be laid down as a general rule, that if a wound is so situated that the instrument of death, when placed in the hand of the deceased, cannot be made to reach it, whether by the motion of the hand itself, or by that of the part injured, or by both jointly, it was not self-inflicted. Wounds on concealed parts of the person, as within the labia, and beneath the breast of the female, are in all probability homicidal. It must, however, be borne in mind that while murderers sometimes inflict injuries of a kind to appear suicidal, many suicides are moved by very eccentric impulses.

Extent of the Wound.—It has been thought that a suicide would not have courage or strength to inflict a very extensive wound upon himself; but experience is opposed to this view. Suicidal wounds of the throat, for instance, are usually deep and extensive; and nothing is more common than to read of the head being nearly severed from the body. Superficial wounds of the throat are, however, among the most common forms of pretended suicide.

Direction of the Wound.—Suicidal wounds generally follow the natural movement of the arm from left to right, and from above to below. But in the case of left-handed persons, the direction would be reversed. Wounds of the throat, whether suicidal or homicidal, are, however, generally transverse. When persons of different statures fight together, a wound inflicted by the taller man would pass from above downwards, and the reverse if given by the shorter, supposing both combatants to maintain the erect posture. In wounds inflicted by a sword, or by fire-arms, it is always important to notice both their direction and the orifices of entrance and exit.

Number of Wounds.—The coexistence of several mortal wounds affords a presumption against suicide, but only a presumption; for after inflicting on themselves wounds necessarily mortal, suicides have retained strength and determination to inflict others. Thus Orfila relates the case of a gentleman at Rouen found dead in his chamber, with two pistols lying, one near the body, the other on the bed, at some distance from it. He had shot himself in two places. One wound, apparently made while he was on the bed, had traversed the left side of the chest, breaking a rib before and behind, perforating the middle portion of the lung, and passing near the roots of the pulmonary veins. A large quantity of blood was extravasated in the chest. After inflicting on himself this serious injury, the deceased must have risen from the bed, walked to a closet to get another pistol, with which he produced a second wound that must have killed him instantly. The ball had entered the frontal bone, and, after traversing the left hemisphere of the brain, had lodged against the os occipitis. There was not the least doubt of this having been a deliberate suicide.

Watson gives a case of suicide in which no less than ten wounds were inflicted on the throat.

It is scarcely necessary to observe that most of the probabilities just established may lead to error if too implicitly relied upon; so that in doubtful cases we must guard against false inferences from circumstances purely accidental as well as from arrangements made to deceive us.

Nor is it always safe to assume that a severe injury, actually inflicted by another, is the real cause of death; for, as in a case related by Wildberg, a death occurring during a chastisement may, on examination, be found to have been due to poison.

The *circumstantial evidence* in death by wounds is of the first importance, and has been already alluded to under "persons found dead" (p. 244). Thus Sellis, a servant of the Duke of Cumberland, afterwards King of Hanover, was found dead on his bed with his throat cut, while his master was under the care of Sir Everard Home, severely wounded in the head and hand. The Duke stated that he was roused from sleep by a blow on the head, followed by several others, one of which caused an immense effusion of blood; that he leaped out of bed, and followed his assailant, who repeatedly struck at him, and would doubtless have murdered him, but that the doors protected his person from some of the blows. Every part of this statement was confirmed by the circumstantial evidence. The coloured drapery at the head of the Duke's bed was sprinkled with blood; there were traces of blood on the passages and staircase, and on the doors of all the state apartments; and Sellis's coat was found on a chair out of reach of blood from his bed, but the sleeve was sprinkled from the shoulder to the wrist "with blood, quite dry, and evidently from a wounded artery."

When Lord William Russell, the victim of Courvoisier, was found dead in his bed with his throat cut, the facts that the instrument of death did not lie near the body, and that a napkin was placed over the face, left no doubt whatever that he had been barbarously murdered. Again, when a woman of the name of Norkott was found dead in her bed with her throat cut, the fact that, on the *left hand* of the deceased, there was a bloody mark of a *left hand*, was conclusive evidence of her having perished by the hand of another.

Besides the questions already examined there are others which may have to be considered. We may be asked whether a given wound is dangerous to life, and, of many wounds, which was mortal. It may also be important to know how long the wounded person survived the injury, and to fix the point of time at which a wound was inflicted. These questions will now be briefly discussed.

Is the Wound dangerous to Life?—This question is easily answered in the case of injuries to the large blood-vessels and important viscera of the body, but less easily in the case of injuries which affect life rather by their extent than by the importance of the parts implicated; for while, on the one hand,

slight injuries to parts altogether unimportant may, in peculiar states of constitution, prove fatal, on the other, recovery may take place from injuries the most severe and extensive, as in the well-known case of Mr. Tipper, who was pinned against a stable-door by the shaft of a gig traversing the chest.

The danger attending injuries of the several important parts of the body will be found discussed under the next heading.

Of many Wounds, which was mortal?—It is easy to understand how this question may become important in a medico-legal point of view. A mortal struggle may begin with blows and end with the use of a stabbing or cutting instrument, and the crime would have a very different aspect, according as the death was attributable to the blows or to the stabs or cuts. The question is of so general a nature that it must suffice to indicate its importance.

How long did the wounded person survive?—This question, too, may evidently assume importance, especially in connexion with the amount of exertion possible after severe injuries. But the question, as one of detail, can be answered only as in the next division.

When was the Wound inflicted?—This question may arise either during life or after death. During life the question must be answered, in the case of contused wounds, by the extent of the ecchymosis and the colours it assumes; in the cases of incised and punctured wounds, by the state of the divided parts, whether they are filled with extravasated blood or not; and whether the edges are swollen, and the surrounding skin inflamed. After death the question either resolves itself into the simple inquiry, How long has the deceased been dead? or into the double question of the date of the death and the length of time that the deceased survived the injury. The presence or absence of animal heat, of cadaveric rigidity, and of putrefaction, and the progress which putrefaction may have made, must be taken into account. These changes in the condition of the dead body take place, as has been already observed (p. 233), with very different degrees of rapidity in different subjects; so as to oblige us to speak of the time occupied by them with caution and reserve.

V. WOUNDS AS THEY AFFECT THE SEVERAL PARTS OF THE BODY.

Some of the questions which have been merely indicated as important in the previous division, will be examined in detail in this.

Wounds of the Head.—Injuries to the *scalp* are more important than those of the integuments of other parts, partly on account of the peculiar tendency of the skin itself to take on the erysipelatous inflammation, partly from the quantity of loose areolar tissue intervening between the tendon of the occipito-frontalis and the periosteum, which is very liable to become the seat of diffuse inflammation; and partly from the relation of the tendon to this lax tissue, preventing, as it does, the escape of effused products. Punctured wounds of the scalp are dangerous on account of the inflammation which they set up in this tissue, and the want of free exit for the discharges. Contused wounds are also dangerous for the same reasons. On the other hand, extensive lacerated wounds which do not involve the periosteum are rarely productive of serious consequences, inasmuch as they afford free passage to the products of inflammation.

Fractures of the Skull are not more important than those of other bones, unless they are attended by injury to the brain or its membranes. But in this case, as in that of wounds of the scalp, a slight injury may lead to fatal consequences, while complete recovery may take place after very extensive injury. The force that occasions the fracture may also produce concussion, or other injury to the brain. It is important also to understand, that a blow does not always fracture the bone on which it alights, but that it may produce a counter fracture at an opposite part of the skull. A severe blow or fall on the vertex of the head, for instance, will often occasion a fracture at the base.

In forming an estimate of the danger attending fractures of the skull, it is necessary to bear in mind the different thickness of its several parts. Thus, a blow on the temple would be productive of greater injury than one of equal force applied to other parts of the cranium. The orbitar plate is another part which by its extreme thinness exposes the brain to serious injury from thrusts with pointed instruments. The cribriform plate of the ethmoid bone again would be easily fractured, and the base of the brain be readily injured by a sharp-pointed instrument thrust up the nostril.

Injuries of the Brain itself will have to be considered under the distinct heads of concussion, compression, wounds, and inflammation.

Concussion.—This is a common effect of severe blows or violent shocks. The symptoms often follow immediately on the accident, and death takes place without reaction, or any improvement from the usual remedial means. In other cases the symptoms of concussion and compression are combined, and

in others, again, concussion is followed by compression or inflammation.

Several cases of death by concussion are on record in which no lesion of the brain could be discovered. Thus, Mr. Travers, in his work on 'Constitutional Irritation,' gives the case of a prize-fighter who was taken off the ground insensible, and apparently apoplectic, and died in eight hours; yet no lesion or extravasation could be discovered on careful inspection of the brain.

The interval which elapses between the receipt of this form of injury, and the fatal termination, is very various. It may prove fatal, as in the case just quoted, in a few hours, or after the lapse of several days, weeks, or even months. Thus Richard Wiseman, in his chapter on Wounds of the Head, gives the case of a lady who received a blow on the head while riding under a pent-house. The blow stunned her, and she died after many months of suffering with symptoms pointing to abscess of the brain.

It is a remarkable circumstance connected with this class of injuries, that the patient sometimes seems to suffer little or no immediate inconvenience; but, after the lapse of some days, is seized with symptoms of compression or of inflammation of the brain. Thus, Mr. Pott gives the case of a woman who received an injury on the head, and after remaining well twelve days, fell ill, and died with symptoms of compression. The ventricles were found to contain bloody serum, and a small coagulum. And Abercrombie gives the case of a girl, aged thirteen, who fell from a swing, and struck her head violently against the ground. For six weeks after the accident she complained of headache, but was not otherwise ill. Feverish symptoms then came on, followed by slight delirium and coma, and she died two months after the fall. The ventricles were found distended with serous fluid, without any other morbid appearance.

Compression.—This may be caused by depressed bone, or by effused blood or serum. The symptoms come on suddenly or gradually, according to the nature of the compressing cause, and the fatal result follows in varying intervals of time. In cases of compression produced by depressed bone, the cause of death is obvious, and can give rise to little difficulty; but when it arises from effusion of blood or serum following an injury, it is easy to allege that the effusion and consequent fatal result were due, not to the injury itself, but to some concomitant circumstance. Thus, if in the course of a struggle a man is thrown down or struck, and dies soon after, with symptoms of compression, and it appears that an effusion of blood has taken place,

the effusion may be attributed to the excitement of the contest, and not to the injury itself; and the question will be even more difficult if the deceased was given to habits of intoxication, or was of a plethoric habit and apoplectic make, or of an advanced age. The inquiry will be still more difficult, if on dissection the vessels of the brain are found diseased; but as effusion of blood rarely takes place *on the surface of the brain* from disease, the difficulty will only attach to effusions at the base, in the ventricles, or into the substance of the organ.

Wounds.—These injuries present considerable difficulty in a medico-legal point of view—a difficulty which cannot be better set forth than in the words of Richard Wiseman. He says, "the greater symptoms that are usually said to attend the wounds of the brain do show themselves more uncertainly than a speculative chirurgeon would imagine; and in cuts and wounds made by sharp weapons or sudden strong force, more uncertainly than in contusions, concussions, and depressions of the skull; the highest of them, viz., vomiting, stupor, loss of spirits, with a paralysis of legs and arms, arising more suddenly in these latter cases than in the former." "Nay, we see many die suddenly from a box on the ear, and from small blows or wounds. In some whereof, upon opening the cranium, there hath been much blood extravasated: in others none at all, or aught else that may be thought to have killed the patient." "Others I have been called on to see opened, when there had preceded only a contusion of the calvaria, without any fissure, or more extravasated blood than is usually seen in every opening on taking off the cranium: yet the patient lay, as I am informed, under all those symptoms of delirium, coma, &c. Then, again, I have drest many that had been cut through the skull, the shivers of bones lying pasht with the flesh and hair upon the dura mater: yet the patient hath been without any symptoms of such a wound; which I suppose happened by reason of the bones lying loose upon the membrane."

Of severe symptoms speedily supervening from a slight injury the following is an example:—A young man received a blow on the forehead from a cudgel, soon took to his bed and became delirious: a sopor followed, and after some days he died. A small hair-like fissure was found running from the great canthus of the eye upward. On removing the skull and dura mater but little blood was found extravasated, and the pia mater little altered. Of comparatively slight symptoms following very severe injuries, the following is an example of the opposite kind from the same author:—A soldier was shot in the face by a case-shot, and had "his face, with his eyes, nose, mouth, and forepart of the jaws,

with the chin shot away, and the remaining parts of them driven in. One part of the jaw hung down by his throat, and the other part pushed into it. I saw the brain working out underneath the lacerated scalp on both sides between his eyes and brows." Yet this man, after being carried off as dead, was found next morning knocking against the door of the room in which he had been placed, and was seen standing by the door. He was quite sensible, implored help by signs, and assisted himself to drink. His wounds were dressed, and he remained under Wiseman's care six or seven days, being left alive at the end of that time. An equally remarkable case, illustrating the power of locomotion that may survive very severe injuries of the brain, is related in the voyages of the great French surgeon, Ambrose Paré. "A soldier in my presence gave to one of his fellows a stroke with an halbard upon the head, penetrating even to the left ventricle of the brain, without falling to the ground." After being dressed "he returned all alone to his lodgings, which was at least 200 paces distant." The third day he came staggering to Paré's tent to be dressed, but died under his hands in a convulsion. Paré says: "I have recited this history as a monstrous thing, that the soldier fell not to the ground when he had received this great stroke, and was in good senses even till death."

Other remarkable cases of the same kind are to be found in the works both of Paré and Wiseman, and many modern cases might be cited, but the following will suffice. Thomas Fothergill was charged before Mr. Justice Willes at Newcastle with the wilful murder of John Smith. The prisoner knocked the deceased down by a blow on the head with a pickaxe, and then struck him again with the pickaxe on the body. After a time the deceased was able to walk to his lodgings, from which he was taken to the Newcastle Infirmary, where he died ten days after. On examination, it was found that the temporal bone had been driven in and had lacerated the brain; and the spleen was also found torn. Either injury was sufficient to cause death.

Inflammation.—This may follow upon injuries, not only to the organ itself, but to the scalp, and the parts most nearly connected with the brain, such as the orbit and ear. The severity of the inflammation is not always proportioned to the injury received. A slight injury may give rise to very severe inflammation, a severe injury to very slight effects. The period at which inflammation sets in is also very variable. As a general rule, it does not follow directly upon the injury, but several hours, some days, or even weeks may elapse before it takes place.

Injuries of the head, then, have this peculiarity, that at first they often appear of little consequence, but after a considerable interval dangerous symptoms may arise and prove fatal. Railway accidents have more than once given rise to difficult questions relating to this class of injuries. The symptoms of injury to the nervous system have not shown themselves at once, but the following day, or after a still longer interval, and much difficulty has been experienced by the jury in awarding damages, in consequence of conflicting medical opinions. In the interval which elapses between the receipt of the injury and the accession of dangerous symptoms, there is always room for neglect or mismanagement, on the part of the patient, his friends, or the medical attendant, which may materially affect the question,—Was the injury the cause of death?

Injuries to the Spinal Cord.—This, like the brain itself, is subject to concussion; to compression, from effusion of blood on its surface or in its substance; and to wounds from fractured vertebræ. Concussion and compression may follow severe shocks, as in railway accidents; the more severe injuries arise from falls or blows, or sudden twisting movements of the neck. Injuries to the substance of the cord generally prove fatal, the interval varying according to the degree of violence and the part of the spine that has been wounded. Serious injury to the upper part of the cord proves immediately or speedily fatal by paralysing the muscles of respiration; injuries to the cord opposite the lower cervical vertebræ (the fourth, fifth, sixth, and seventh) prove fatal in from four or five hours to as many weeks or months: in rare instances not till the lapse of years. In the case of John Carter of Coggeshall in Essex, displacement of the last three vertebræ with pressure on the cord opposite the seventh vertebra, did not prove fatal for fourteen years. When the cord is injured in the dorsal or lumbar region there is loss of power and sensation in the parts below the seat of injury, with retention of urine and loss of power in the sphincter ani, requiring constant medical aid and careful nursing. With these aids life may be prolonged for years. Many injuries to the brain principally affect its base, and by causing pressure on the medulla oblongata impair the functions of the nerves supplying the muscles of respiration.*

Wounds of the Face.—These injuries obviously produce great disfigurement, and, in consequence of the large distribution of important nerves over the face, still more grave inconvenience.

* For a group of cases of injury to the cervical portion of the spinal cord, consult 'Lancet,' July 19, 1856, p. 85. See also 'On Concussion of the Spine,' a clinical lecture by Mr. Skey, 'Lancet,' Jan. 10, 1857.

From the near proximity of the principal features to the brain, there is also a risk of injury to that organ, as well as of inflammation extending from the seat of the wound. In this respect wounds of the face rank next in importance to those of the scalp.

Wounds of the Throat.—These injuries are important from their frequency. They are the chosen mode of death with a great majority of suicides, and sometimes a murderer inflicts a wound on the same part in the hope that his victim will be supposed to have committed suicide. The degree of danger depends upon the position and the parts implicated. Wounds of the anterior part of the throat are less dangerous than those of the side of the neck; those of the lower part of the throat, less so than those of the upper part. A division of the carotid artery is almost necessarily fatal, and that of the internal jugular vein attended with great danger from hæmorrhage, from the introduction of air into the circulation, and from phlebitis. Wounds of the larynx or trachea are attended with comparatively little danger, and those of the trachea are less important than those of the larynx.

The question, Was the wound the cause of death? is easily answered, but the question, Was the wound suicidal or homicidal? is less easy of solution. There is also a question of considerable interest relating to wounds of the threat, namely, What amount of voluntary motion is possible after the receipt of a severe wound?

The questions of suicide or homicide, and of the amount of voluntary motion possible after a severe wound in the throat, were raised in the case of Captain Wright, who shared the captivity of Sir Sidney Smith and his celebrated escape from the Temple, and who had the misfortune to be taken a second time and imprisoned in the same place. He was found dead in his bed with his throat cut, and the razor closed in his right hand. There was an extensive transverse wound on the anterior and superior parts of the throat, above the bone of the windpipe, cutting through the skin, the muscles, the windpipe, the gullet, and the blood-vessels, and penetrating to the cervical vertebræ. The circumstances of the case are involved in so much mystery that it is impossible to determine by the evidence collected with great pains by Sir Sidney Smith, whether Wright really committed suicide or not. But it is easy to show that the mere fact of the razor being found closed in his hand does not militate very strongly against the supposition of suicide; for, in the case of a military officer, which occurred in September, 1838, the head was found nearly severed from the body, and there was no doubt that the act was suicidal, yet the razor did not fall from

the hand, but was put on the dressing-table. In a more recent case, a madman, after inflicting a severe wound on his throat had time to struggle with the maid-servant before he fell down dead. In October, 1833, a man cut his throat with a razor while walking along Oxford Street. He divided the carotid artery and several of its branches, the jugular vein of one side, and the trachea; yet he was seen to hold a handkerchief to his neck, and to run four yards before he fell dead on the pavement. He held the razor firmly grasped in his hand.

In the remarkable case of Mary Green, murdered in 1832 by John Danks, the confession of the culprit, and the circumstantial evidence coincided to prove that, after a wound which divided *the trunk of the carotid artery, and all the principal branches of the external carotid, with the jugulars,* she must have risen from the ground, run a distance of *twenty-three yards,* and climbed over a low gate. It required at least from fifteen to twenty seconds to run from the spot on which the murder was committed to that on which the body was found.

Wounds of the Chest.—Incised wounds of the walls of the chest are not attended with any peculiar danger; but severe blows, by causing fracture of the bones, and consequent injury of the internal parts, often prove fatal, death being due to rupture of the viscera, to hæmorrhage, or to inflammation. Severe contusions of the chest may also terminate fatally by the shock they occasion. Such injuries are common in prize-fights, in falls from great heights, and from heavy objects crushing the chest. Penetrating wounds of the chest can scarcely fail to injure some important organ, occasioning thereby fatal hæmorrhage or severe subsequent inflammation; but cases are recorded of sword and gun-shot wounds traversing the chest without causing any bad symptoms; and most of the cases of injury to the chest that were under Wiseman's care after the battle of Dunbar seem to have recovered.

Wounds of the Lungs.—Hæmorrhage is the immediate consequence of these injuries. The blood may be discharged by the wound, or by expectoration, or it may accumulate in the cavity of the pleura, causing great difficulty of breathing. When the large vessels are wounded the hæmorrhage is copious and speedily fatal. Injuries to the substance of the lung itself are not necessarily fatal, for patients have recovered after removal of a portion of the lung, and, in rare instances, foreign bodies, such as bullets, have remained in the lung for years, and have been inclosed in a cyst. Inflammation is a common consequence of these wounds, especially when a foreign substance has been introduced, as happens in injuries with fire-arms. Cases of wounds of the lungs

require careful management, and long-continued rest, without which injuries that have been repaired may be reproduced. Emphysema is a familiar effect of this class of wounds; but when judiciously treated it does not materially increase the danger.

Wounds of the Heart.—Penetrating wounds of the heart are necessarily speedily fatal from hæmorrhage, unless they pass so obliquely through the parietes that the flap acts like a valve, or a foreign body happen to plug the orifice. Death may be delayed, in these cases, for some hours or even days. The rapidity with which death takes place will depend upon the situation of the wound. Thus wounds of the base will prove more speedily fatal than those of the apex, and superficial wounds dividing its nutrient vessels less promptly than those which penetrate its cavities. John Bell gives the case of a soldier, in whom the apex of the heart was cut with the point of a very long and slender sword; and yet this soldier lived twelve hours, during which time, as appeared after his death, the heart had, at every stroke, been losing a small quantity of blood, till it entirely filled the chest, and the patient died suffocated. Another man was wounded with a sword, the point of which cut the coronary artery; but it was two hours before the pericardium filled with blood, and then, after great anxiety, the patient died.* In very rare instances, when the wound does not prove fatal by hæmorrhage, complete recovery takes place; as in a case related by Fournier, and authenticated by M. Mansen, chief surgeon to the hospital at Orleans, of a patient, who died after the lapse of six years from the date of a gun-shot wound, from disease unconnected with it, and the ball was found embedded in the heart. MM. Ollivier and Sanson have collected a number of cases of penetrating wounds of the heart, with a view of determining the probable period at which they prove fatal. Out of twenty-nine cases of wounds of the cavities only two were fatal within forty-eight hours. In the remainder, death took place in periods varying from four to twenty-eight days.†

Wounds of the Aorta and Pulmonary Artery are necessarily fatal; but patients have lived a few days after small punctured wounds even of the aorta.

Wounds of the Œsophagus and Thoracic Duct.—Such injuries are necessarily rare from the great depth at which these parts lie. They would be dangerous from the extravasation of their contents. Orfila, however, mentions a case of recovery from a bayonet-wound of the œsophagus.

* 'Principles of Surgery,' vol. i. p. 468.
† 'Dict. des Sciences Médicales,' art. *Cas rares.*

Wounds of the Diaphragm.—Punctured wounds of the diaphragm itself do not appear to be attended with great danger, but they are rarely uncombined with injury to the parts above or below. Hernia of the stomach has sometimes followed these injuries, and proved fatal. Rupture of the diaphragm from severe blows or falls is not an uncommon occurrence. In the majority of cases the rupture is attended by a fatal shock to the nervous system, and death is immediate. In other instances it takes place after a longer interval from the protrusion of the viscera of the abdomen into the chest, and the consequent disturbance of the functions of the organs contained in one or both of those cavities.

Wounds of the Abdomen.—Wounds of the walls of the abdomen may be attended with serious consequences. Death may take place in incised wounds from a division of the epigastric artery. As in the scalp, so here, there is additional danger from wounds of the tendons of the muscles, and the consequent accumulation of matter beneath them. Ventral hernia is a remote consequence of wounds of the parietes of the abdomen. Severe blows are generally attended with serious consequences. Shock, hæmorrhage from ruptured viscera, and inflammation, are the chief causes of death. The liver and spleen are the organs most liable to injury, and rupture of their substance is not uncommon.

Wounds of the Liver.—Penetrating wounds of this organ, when they extend to any depth, are apt to prove fatal by dividing some of the large vessels. In other cases the danger arises from inflammation. Wounds of the gall-bladder prove fatal by causing effusion of bile, and consequent peritonæal inflammation.

Wounds of the Spleen.—Deep wounds are fatal by hæmorrhage; but recovery may take place from superficial wounds. Rupture of the spleen from blows on the belly is not uncommon. It proves fatal, according to the amount of injury, in from a few hours to several days. In a convalescent patient, a kick over an enlarged and extremely soft spleen caused the effusion of several ounces of blood, and death in a few minutes. (Robert Williams, 'Elements of Medicine,' vol. ii. p. 470.)

Wounds of the Stomach.—These prove fatal by the shock to the nervous system; by hæmorrhage, if the large vessels are divided; by the extravasation of the contents and consequent peritonæal inflammation; and by inflammation of the viscus itself. Wounds of the stomach, however, are not necessarily fatal, and many cases of recovery are recorded, even when the wound was extensive, and the stomach distended with food at the time of the injury.

Wounds of the Intestines.—These injuries may prove fatal in the same way as those of the stomach—viz., by hæmorrhage, by effusion of their contents, and consequent peritonæal inflammation, or by inflammation of the part itself. The danger is greater in the small than in the large intestines, from the more fluid state of their contents, and the greater risk of extravasation. For the same reason, wounds of the duodenum are more dangerous than those of the other small intestines. In the absence of extravasation, there is a fair chance of recovery from wounds of the intestines by the effusion and organization of coagulable lymph about their edges.

Wounds of the Kidneys.—The kidneys are chiefly exposed to injury from blows and stabs in the loins. Penetrating wounds may prove fatal, in consequence of hæmorrhage, extravasation of urine, or inflammation. If means are taken to prevent the urine from being effused into the peritonæal cavity, recovery may take place.

Wounds of the Bladder are chiefly dangerous from extravasation of urine, which is, of course, most apt to occur when the organ is distended. In the absence of effusion they may prove fatal by the inflammation to which they lead. Rupture of the bladder, though ultimately fatal, does not destroy life rapidly; and the accident does not immediately prevent the patient from walking about.

Wounds of the Genital Organs.—A removal of the penis, if not fatal by hæmorrhage, is not dangerous; but an incised wound of the urethra entails the risk of extravasation of urine and fatal sloughing. The removal of the testicles is attended with less danger than a contusion. This latter injury sometimes proves fatal by the shock to the nervous system. Wounds of the spermatic cord occasion dangerous hæmorrhage. The complete removal of all the parts of generation of the male has in many instances led to no bad result. Deep wounds of the labia of the female are dangerous from hæmorrhage. Fatal injuries have been inflicted on the uterus, bladder, or rectum, or on the large vessels of the pelvis, by instruments introduced into the vagina.

Consult Mr. Watson's 'Medico-legal Treatise on Homicide.'

VI. DETECTION OF SPOTS OF BLOOD.

The medical jurist may be required to examine red spots supposed to be caused by blood on wearing apparel, on cutting instruments, and on floors or furniture, or wherever they may have fallen; also, in some cases, to examine solutions of blood in water: and he may be asked to assign the source from which the blood,

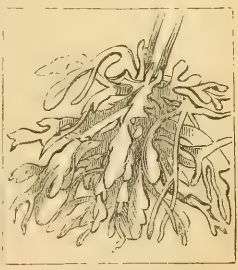
if human, has flowed, and to distinguish human blood from the blood of animals.

When the spot of blood is recent, and the quantity considerable, it presents highly characteristic appearances, and yields a solution of a peculiar colour, readily distinguished from all other red fluids by its chemical and microscopical properties. But when the spots are not recent, and the quantity of blood is inconsiderable, the work of identification is less easy.

Blood is a compound fluid, consisting of *fibrin*, *serum*, and a colouring matter (*hæmatosine* or *hæmatine*), contained in the circular disks known as the red corpuscles. Each of these constituents has characteristic properties which admit of practical application in the diagnosis of blood-stains. The *fibrin* coagulates spontaneously, and enters largely into the composition of the *coagulum* or *clot*. The *serum* is coagulated by heat or acids, and by other reagents; and its coagulation by heat is an element in the diagnosis of the blood-solution. The *colouring matter* has some peculiar reactions presently to be described, and the *red corpuscles*, or globules, are seen as circular disks with characteristic appearances to be also presently described. *Crystals* may also be obtained from the blood by chemical manipulation, and *sublimates* by heat. The fibrin, the serum, the colouring matter, the red corpuscles, the crystals, and the sublimates will now be examined in the order in which they are mentioned.

1. The *fibrin* of the blood has very characteristic properties admitting of application to the identification of blood-stains. When blood fresh drawn is briskly stirred with a rod, the fibrin free from colour clings about it as in fig. 33; and when a single drop is stirred with a needle-point on a glass slide it separates, and presents a similar character under the microscope. It may also be recognised in solutions from blood-stains. Its irregular grouping, variable thickness, clubbed loops, and complete absence of striæ or texture of any kind, form a highly characteristic combination of characters.

Fig. 33.



After Gulliver.

2. The *serum* which enters into the composition of the blood stain may be shown to exist in it by a process founded on the well-known fact that coagulated albumen becomes soluble in water at about

the temperature of boiling oil (350° Fahr.). Professor Bloxam has accordingly suggested that this fact should be applied as a blood-test. The stain, introduced into a strong tube of green glass sealed at one end, is moistened by from half a drachm to a drachm of distilled water. The tube, so sealed at either end as to bear strong pressure from within, is now placed in an iron saucepan containing oil, which is kept boiling for the space of an hour, at the end of which time, the contents of the tube will be found to have acquired a dirty slate colour, and the stain to have parted with some of its colouring matter. The discoloured water, on being tested with nitric acid, bichloride of mercury, and ferrocyanide of potassium, will yield the white precipitates characteristic of the presence of albumen.

The characteristic consistence and colour of the spot, taken in conjunction with this detection of serum as one of its contents, are nearly conclusive of the presence of blood; for it is scarcely within the bounds of possibility that any printed fabric should unite the colour of blood with the use of albumen; and, except in the case of a mere smear or stain of blood, the very consistence of the spot would exclude almost every kind of stain or dye.

3. The *colouring matter* of recent blood-stains is more or less completely dissolved out by *cold* water, and the *blood solution* thus obtained has a vermilion-red colour, which is discharged, and changed to a dirty slate colour, by boiling, at the same time that the serum is coagulated and thrown down. This coagulum, if collected, dried, and boiled in *liquor potassæ*, is completely dissolved, forming a solution, dark green by reflected, and red by transmitted, light. The blood solution has also the characteristic property of not being changed in colour by the addition of a small quantity of *liquor ammoniæ*. With *infusion or tincture of galls* it yields a red precipitate. These tests are quite characteristic. No other red solution has the same reactions. The red, pink, or scarlet infusions of flowers and roots, and the juices of fruits are changed to green or violet by liquor ammoniæ, and cochineal to crimson. The red solution of *sulphocyanide of iron* yields with the same reagent a white precipitate of oxide of iron; and the pink solution of the *permanganate of potash* is changed to blue. Moreover, none of these colouring matters are coagulated and changed by heat. Red colouring matters due to the presence of salts of iron yield a dark-blue precipitate with the infusion or tincture of galls.

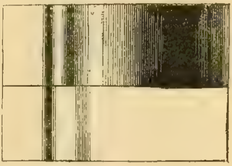
But besides these characteristic properties of the blood-solution, we have two tests of extreme delicacy, of which the one consists in a chemical reaction, the other in a physical change. The first

was suggested by Dr. John Day, of Geelong, the second has been brought to perfection by Mr. Sorby, of Sheffield.

Dr. Day's test, suggested by the discoveries of Schönbein, and justified by his own experiments,* as well as by subsequent careful inquiries of Dr. Taylor,† consists in the joint use of tincture of guaiacum and the ethereal solution of peroxide of hydrogen or "ozonic ether." To a very weak faintly-coloured blood-solution we first add a few drops of tincture of guaiacum, and then a few drops of ozonic ether. The result is a rich sapphire-blue solution.

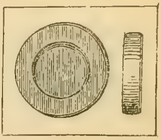
The spectroscope detects the presence of blood in quantity equally small by the presence of two black absorption-bands in the upper part of the green section of the spectrum. The upper of the two spectra in fig. 34 shows the appearance due to a solution of fresh blood, the lower that caused by alkanet root in alum, of which the spectrum has been found to approach more nearly than any other colouring matter to that of the fresh blood-solution. By means of an eye-piece, devised by Messrs. Sorby and Browning, and easily fitted to the tube of any microscope, the blood-spectrum may be procured and examined, compared with other spectra yielded by coloured liquids, and the situation of the absorption-bands ascertained by comparison with a standard invented by Mr. Sorby.‡ This is a blood-test which requires for its successful application the manipulation and minute adjustments of a practised hand, a blood-solution neither too weak nor too strong, and an exact measurement, by reference to the standard, of the position of the absorption-bands.

Fig. 34.



4. The *red corpuscles*, or globules, of the blood have highly characteristic properties. Their microscopic characters require to be minutely described, inasmuch as circular forms are very commonly met with, as in the oil-globules of milk, the spores of yeast, and many crystalloids, organic and inorganic. The appearance of the globules in mammalia is shown in plan and section, largely magnified, in the annexed

Fig. 35.



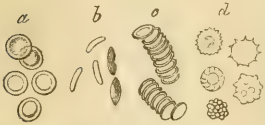
* On Polarized or Allotropic Oxygen. By John Day, M.D. The 'Australian Medical Journal,' No. 73, May, 1867.

† 'Guy's Hospital Reports,' 1867.

‡ The reader is referred to a paper on Spectrum Analysis, by H. C. Sorby, F.R.S., &c., at p. 218 of Dr. Beale's 'How to Work with the Microscope,' 4th edition.

figure, after Gulliver. They have also been depicted in plan as a circular disk with shaded centre, in section as a bi-concave lens. But their appearance differs with the power of the microscope, the light, and the focus. A quarter-inch object-glass is as high a power as it is necessary, or perhaps desirable, to use; and they can be well seen with a good half-inch. When viewed by transmitted light, they appear, when out of focus, as convex disks with faint outline; as we approach the true focus, the outline becomes dark and distinct; and when quite in focus, they seem to have a dark inner margin, a slight shaded depression, or a dark central shadow. Similar changes take place when the mirror is slowly moved, so as to place the object under a succession of brighter and dimmer lights. The observer should provide himself with a standard specimen of human blood globules with which to compare, for form and size, that which happens to be under investigation. The figure annexed shows the blood corpuscles as isolated disks (*a*) in plan; (*b*) in profile; (*c*) aggregated like piles of coin; (*d*) variously contracted and crimped by the exsudation of their contents. See also 2, fig. 5, p. 46.

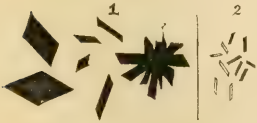
Fig. 36.



Magnified 400 diameters.

5. Blood, either spontaneously or by a simple chemical process, may yield highly characteristic *crystals*. Virchow speaks of them as "one of the surest tests," as well as a most delicate one; and also as one of which he has practical experience in medico-legal cases. He covers the stain with dry, crystalline, powdered common salt, moistens this with glacial acetic acid, and evaporates at a boiling temperature. The dry residue contains crystals of *hæmine* in large numbers. Virchow was able to produce innumerable microscopic crystals from a blood spot a line in diameter. These crystals are represented in fig. 37. The larger ones (1) are after Virchow, the smaller ones (2) are the result of an experiment on a minute recent clot of sheep's blood. With blood stains of long standing this test fails, though the colour left on the glass slide is very characteristic.

Fig. 37.



× 300 diameters. × 150.

Casper* commends the following procedure. A drop of blood,

* 'Handbook,' vol. i. p. 200. The reader will find at p. 196 et seq. of this

or of fluid containing its colouring matter, is mixed in a watch-glass with glacial acetic acid in excess, and evaporated slowly, or spontaneously. The dried mass contains the crystals of hæmine, sometimes isolated, sometimes counting by thousands; rhomboidal, tabular, or "otherwise," faint yellow, yellowish-red, or dirty blood-red, but sometimes colourless. Casper considers the addition of common salt unnecessary but advisable, as rendering the success of the experiment much more certain.

6. *Sublimates.*—When a minute fragment of a blood-spot on linen or cotton textures is heated by the spirit-lamp on a slab of porcelain, and a disk or slide of glass superimposed, two sublimates are deposited on the glass, the first a pure white (at a moderate temperature), the second of the colour of blood (at a higher temperature). The second is reticulated, and resembles empyreumatic sublimates resulting from the decomposition of animal matter. The first assumes such forms as are yielded by many of the alkaloids; and, when the temperature of the superimposed glass is favourable, groups of well-defined prismatic crystals. I have specimens of such crystals from human blood, and from the menstrual fluid. At present this statement must be taken to form part of the natural history of the blood-stain. Its practical value has yet to be determined.

It may be well to add that in the case of blood-spots on clean linen or cotton textures, the presence of animal matter may be ascertained by placing a stained fragment in a reduction-tube, heating with a spirit-lamp, and testing the ammoniacal vapours as they issue by moistened turmeric paper. This process proves the existence of some animal matter; and added to the eminently characteristic colour and consistence of the spot, goes far to prove the presence of blood.

A selection will now be made from among these characters of blood-spots for practical application by those who possess an adequate acquaintance with chemical tests and the microscope.

volume notices of several methods of procedure not described in the text, such as Morin's with liq. potassæ, hydrochloric acid, and ferrocyanide of potassium, to detect the iron of the blood; Wiehr's process (for stuffs not containing wool), by roasting the stain, rubbing it to powder, mixing with carbonate of potash, exposing to a strong red heat, washing the fused mass with distilled water, adding to the filtered solution a mixed salt of iron, and digesting the precipitate in dilute sulphuric acid, and thus bringing out the characteristic Prussian blue; Bryk's process by concentrated sulphuric acid applied to the stain under the microscope, successive colours—green, brown, violet, brick, or rose-red—being produced, but with the serious drawback of not being peculiar to blood; and Hoppe's process with caustic soda, which, when dropped on recent blood-stains, developes an olive-green colour, passing to the original tint on the addition of acetic acid, and back again on the re-addition of soda—a highly characteristic reaction.

Blood-stains on articles of dress may be recognised by their consistence and colour, and more completely identified by microscopic and chemical examination. A spot of blood not disturbed by contact or friction feels like thick gum or starch. Small spots are circular, larger spots approach the circular form, and large and small alike have a defined and abrupt margin. Arterial blood has at first a rich red colour, and venous blood a purple hue. Venous blood first grows brighter by exposure to the air, but, after a time, in common with arterial blood, assumes a venous tint. After the lapse of a few hours, the blood, whether from an artery or vein, assumes a peculiar reddish-brown colour, which it retains without change for years. Blood-stains on white calico twenty-five years old have undergone no perceptible change.

The colouring matter of these stains may be procured for examination in the following manner. The stained fragment of cloth is to be cut out, placed in a test-tube with a small quantity of cold distilled water, and shaken for a few minutes. A recent stain so treated may yield a red, or reddish-brown solution, of a sufficient depth of colour to give characteristic results with all the tests of the blood-solution,—with liq. ammoniæ, infusion or tincture of galls, and on boiling; as well as with the guaiacum- and ozonic-ether-test, and the spectroscope.

But older stains give up their colour very slowly and imperfectly, whether suspended in distilled water, as usually recommended, or agitated with water in a test-tube; and the process is not much hastened by separating the fibres of the cloth. For these older stains, therefore, a different process is required. The stain is to be moistened with a few drops of distilled water, and scraped with a scalpel or sharp knife. To the small quantity of coloured liquid thus obtained a drop or two of glycerine or syrup is to be added. The resulting liquid, placed on a glass slide and covered with microscopic glass, will be found to contain the red corpuscles figured at p. 314, and portions of fibrin (fig. 33, p. 311), mixed with fibres of the cloth. Stains on white calico twenty-five years old have yielded highly characteristic results when treated in this way.

It is to old blood-stains, and the solution obtained from them, and to mere smears of blood, that the guaiacum-test is specially applicable. The mode of applying it may vary with the material bearing the stain. When it is on a linen or cotton texture, the following procedure may be recommended as convenient, and as illustrating the extreme delicacy of the test:—Cut out a small spot, or part of a spot, with a portion of the unstained cloth; detach one of the fibres and cut it off so as to leave at the cut

end the smallest visible coloured speck; and place it on a microscopic slide, with the stain under the field. Moisten it with a drop of the tincture of guaiacum. The colour of the tincture being not unlike that of the spot itself, its colour will be somewhat heightened. But, on adding a drop of ozonic ether, the stain will be found to change rapidly to a beautiful sapphire blue, which colour passes gradually into the surrounding liquid. When the stain is on a texture which cannot be thus unravelled, and especially when the texture is coloured, the best way is to moisten the spot with the tincture of guaiacum and then with the ozonic ether; and to place upon it successive fragments of white filtering paper. These will be found to have the characteristic blue stain.

Beyond the tests just recommended no others are really needed; but the whole of the properties by which blood-stains are characterized may be identified by experiments with small fragments of small stains.

Iron-moulds on linen have, as in a case related by Devergie, been mistaken for spots of blood; but the distinction is easy. Cold water dissolves the colouring matter of blood more or less quickly and completely; but it does not affect the iron-mould. Hydrochloric acid dissolves out the iron, which may be identified by its characteristic tests.

Blood-stains on floors and furniture may be identified in the manner just recommended. The stained portion of wood should be cut out, moistened with distilled water and scraped; or the small clot of blood may be carefully detached and placed in distilled water.

Blood-stains on articles of steel and iron are readily identified when they present themselves in the form of clots on a clean bright surface of metal. They are then of a clear red, or reddish-brown colour, are easily detached, and scale off on exposure to a moderate heat. The presence of animal matter in the spots is readily ascertained by heating them in a reduction-tube. Ammonia is given off, and identified by its alkaline reaction on turmeric paper. A small particle of blood-crust is sufficient for this purpose. The crust placed in a few drops of distilled water will, after a time, yield a reddish-brown solution with the reactions already described; and if treated with syrup or glycerine, and placed under the microscope, will be found to contain blood-globules.

If the blood is merely smeared upon the instrument it will not scale off when heated; but it will be necessary to moisten the stain with distilled water, and scrape it off carefully for examination by tests or the microscope.

If the instrument has been for some time exposed to air and moisture, spots of rust will be mixed with those of blood. In this case, too, the stains are not detached by heat, and it will be necessary to scrape them off, place them in distilled water, and separate the insoluble particles of rust by filtration. The resulting coloured liquid will have the chemical and microscopic characters of the blood solution.

Two other kinds of spots on articles of steel or iron have been pointed out as liable to be mistaken for spots of blood—namely, spots of rust and spots produced by lemon-juice, vinegar, or other vegetable acid.

Spots of rust somewhat resemble blood-spots in colour, but they do not scale off, and are not soluble in water. If thick enough to be detached, they are readily separated by filtration, leaving the water quite clear, and not affected by the tests for iron. A drop of hydrochloric acid placed on the spot of rust dissolves it, and leaves the metal clean, and on diluting the solution with distilled water, evidence of the existence of iron may be obtained by appropriate tests.

Spots of lemon-juice have been mistaken for those of blood. A man, as in a case related by Orfila, was suspected of having murdered another, and a knife, apparently covered with blood, was found in his possession; but on examining the knife, the spots were found to be due to citric acid. The instrument had been used some days before for cutting a lemon, and had been put by without being wiped.

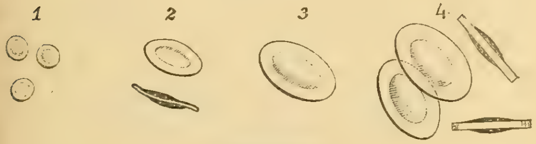
The thinner spots produced in this way have a reddish-yellow, the thicker a reddish-brown, colour, nearly resembling that of blood, and they separate, like blood-spots, when moderately heated. When heated in a tube they give off a volatile matter, which has an *acid* reaction—spots of blood have an *alkaline* reaction. The solution in distilled water is *light yellow*—that of blood is *red;* it sometimes has an *acid* reaction—that of blood is *neutral*, or *faintly alkaline;* with infusion of galls it yields a *black* precipitate, a *blue* with ferrocyanate of potash, and a rich cherry red with the sulphocyanide of potassium. Blood yields a *red* precipitate with the first test, and is unaffected by the others. The oxide of iron is thrown down by alkalies.

It having been clearly made out that the stain we have been examining is a blood-stain, three questions may arise: 1. *Is it human blood, or that of an animal?* 2. *From what part of the body did it flow?* 3. *What is the age of the stain?*

1. *Human blood and that of animals.*—Two means of diagnosis have been proposed, the one microscopic, the other chemical.

Diagnosis by the microscope.—The only means of distinction under the microscope is afforded by certain well-known differences in the shape and size of the corpuscles. The human blood-corpuscle, depicted in fig. 36, p. 314, is a circular flattened disc; and that of mammals, with a single unimportant exception, has the same form. The only appreciable difference is in the size of the globules. In man they measure on an average $\frac{1}{3200}$ of an inch; in animals the diameters vary from $\frac{1}{3540}$ to $\frac{1}{6366}$. But these are only averages; and the extreme measurements which in man may be stated at $\frac{1}{2000}$ and $\frac{1}{4000}$, lie, in some animals, still wider apart. When it is borne in mind that, in most instances, we have to examine a blood-solution obtained from dried blood, made to approximate to the average density of blood by the addition of syrup, glycerine, or a saline solution; that the size of the globules is materially affected by the density of the medium in which they float; and that in the blood itself the diameter of one globule may be twice as great as that of another, it is not to be expected that the most skilful and practised person should be able to distinguish human blood from that of other

Fig. 38.



× 400 diameters.

mammals. But the blood-corpuscles of birds, reptiles, and fishes differ so widely in size and shape from those of man and animals, as to enable us to state positively that the blood in a given case is either that of a mammal, or belongs to one of the three classes of creatures just specified. The differences of size and shape in the human blood (1), the blood of the common fowl (2), the blood of the frog (3), and the blood of a fish (4), are shown in fig. 38. (For some minute details of measurements in Mammalia, see 'Micrographic Dictionary,' Art. Blood; also Plate 40.)

Chemical Diagnosis.—It was Barruel who first proposed to distinguish the blood of different animals by the characteristic odour given off on adding sulphuric acid. If this acid, diluted with half its bulk of water, is added to the blood of an animal, an odour is perceived which closely resembles that of its perspira-

tion; and probably persons would recognise the odour if informed of its existence, and equally probable that they would be mistaken if asked to name the animal which had supplied the blood.

I make this statement as the result of experiments with fresh blood of different animals, in such quantity as a drachm or more, made in the class-room for several years in succession. The majority have always been wrong in their guesses; but on one occasion, a member of my class was uniformly right in his opinion, though the experiment was so devised as to preclude mere guessing. As a means of distinguishing spots of blood, or solutions obtained from them, this test must certainly be disallowed. It has utterly failed in the hands of very competent persons.

In 1844, Professor Taddeï published at Florence a treatise, in which he proposed to distinguish the blood of man from that of other creatures by a method as remarkable for its minute complication as for its eminently uncertain results. Briand and Chaudé, in their 'Manuel' (7th edition, p. 748), describe the method at length, and present us with a tabular arrangement for the mammalia which sufficiently justifies this short notice of it. In this table the blood of carnivorous animals (cat, fox, and dog), and of the mouse, are grouped with that of man as *très fluidifiable*, while the majority of our domestic animals are grouped as *médiocrement fluidifiable*, and a small group of ruminants as *non-fluidifiable!*

2. *Source of the blood.*—In some cases the spots submitted for examination are found blended with hair, skin, or mucous membrane, or with other matters adhering to the material on which the blood has fallen. The discovery of such admixtures may often supply very important medico-legal information; but the subject is one of too great extent to be fully examined in this place. Such examinations as these should always be entrusted to persons having perfect knowledge of the microscope, and large experience in the use of the instrument. One obvious precaution is to examine the fibres or fragments of the texture or material to which the blood adheres, so that they may not be confounded with coagulated fibrin.

Age of the spots or stains.—Dr. Pfaff has suggested a solution of arsenious acid (gr. j to ℨij) as a blood-solvent and means of ascertaining the age of a stain. He thought that he could fix the age by the quicker or slower solution of the colouring matter. His own loose statements as to the time required sufficiently condemn his not very promising proposal.

CHAPTER IV.

DEATH BY FIRE—SPONTANEOUS COMBUSTION—DEATH BY LIGHTNING—BY COLD—BY STARVATION.

DEATH BY FIRE.

On the average of the five years 1852-56, 2623 deaths in England and Wales were attributed to the agency of heat. Of this number 483 were burns, of which 436 were by clothes catching fire, 15 by conflagrations, 24 by gunpowder and fireworks, and 7 by explosive gases. 1548 deaths from the same causes were less accurately defined. 46 deaths were caused by drinking hot water; and 541 deaths by scalding liquids. In the whole five years, 2 suicides, 1 murder, and 4 manslaughters were attributed to burning, and 2 manslaughters to scalds.

The cause of death by burning is not always the same. Some are suffocated by the smoke; others die from shock occasioned by fright; others by blows from falling bodies; others by shock following on extensive injury to the tissues; and others, at periods more or less remote from the burning, by collapse, or the effects of inflammation and its sequelæ. The appearances produced by burning consist of blisters, entire or burst, roasted patches, sooty spots and marks from burnt articles of clothing, and singed hair.

The medico-legal questions that arise in reference to death by fire are similar to those relating to other forms of external injury, except that the alternatives of suicide and homicide rarely present themselves. The great majority of deaths by fire are accidental. In these, and in the rare cases of suicide and murder, the burning would leave marks on the body showing that it was inflicted during life; but as the burning of the body is sometimes resorted to by a murderer to conceal the real cause and mode of death, it may be of the utmost importance to distinguish burns inflicted during life from burns inflicted after death. Another medico-legal question may arise when a body is found with marks of burning too extensive to be readily accounted for by the quantity of fuel consumed. It may become a question whether the body

so injured was unusually combustible, or whether it might not even be the subject of "spontaneous combustion." This second question will be examined separately.

Distinction between burns inflicted during life and after death.—We owe the earliest experiments on this subject to Christison. But their results have been somewhat modified by subsequent experimental inquiries in France and Germany, but especially by those of Casper, and of Champouillon and Chambert. The last-named author seems to have exhausted the subject both by the number and accuracy of his experiments, and we shall therefore adopt the conclusions at which he has arrived, with modifications suggested by the more certain of the results of the earlier writers.

Burns inflicted during life by bodies not so highly heated as to char and destroy the tissues, produce two characteristic appearances—redness and vesication. The redness, more or less intense according to the temperature and the length of its application, is of a deep tint, described by Casper as "crab-red." It affects the surface and entire substance of the true skin, which is dotted by the deep red openings of the sudoriferous and sebaceous ducts; and it also extends to the subcutaneous tissues. Sometimes the colour is a brownish red, and the skin dry and parchment-like. Blisters, more or less numerous and extensive, also make their appearance at a temperature below that of boiling water, and contain serum, which either coagulates in mass, or yields an enormous precipitate of albumen when heated, or treated with nitric acid. The albumen is more abundant when wholly due to vital action than when the burn, being inflicted at the point of death, the vesicle forms after life is extinct. These appearances belong equally to burns made at the point of death and to those made twenty hours previously. Vesicles are sometimes absent in burns whatever the period at which they were inflicted.

On the other hand, in burns inflicted after death, the surface and substance of the true skin are a dull white, dotted with gray at the openings of the sudoriferous and sebaceous ducts, and the subcutaneous tissues are uninjected. No vesicles are produced by a temperature below 212° Fahr.; and those occasioned by a higher temperature either contain no fluid, or one which, as it contains little albumen, merely becomes opaline or milky when treated by heat or nitric acid. Post-mortem vesicles are most readily produced in anasarcous subjects.

The appearances caused by burns inflicted during life, show themselves in all healthy subjects, and probably in the large majority of the sick; but the case of a consumptive patient reported by M. Bouchut, shows that the application of heat to the skin of

a dying, man may produce as little effect upon it as upon a corpse.*

Casper sums up the results of very numerous experiments by stating that "vesications can be produced on the dead body," and "that it is quite impossible to confound a burn inflicted during life with one inflicted after death." He also alleges that "every vesication produced by burning" during life "has a purple-red boundary line, be it ever so narrow, perfectly visible to the naked eye, and also a more or less red base." Vesicles caused by putrefaction are readily distinguished by the absence of these appearances, the exposed true skin being, like that of adjacent parts, colourless or green. The appearances just described as due to the application of heat to the living body are common to all intense inflammations of the skin, whether due to disease, or produced by the application of cantharides and other strong stimulants, by pressure, or by friction.

I have seen, on the ankles of a young man who had died of acute phthisis, two patches of inflammation of a deep red colour not removable by pressure, and with well-defined margins, on one of which were large vesicles containing serum. I ascertained beyond doubt that the spots, which had been observed during life, were not caused by the application of any heated body. In all these cases of acute cutaneous inflammation, a thin vertical section of the inflamed skin and underlying tissues displays, even to the naked eye, distinct red patches, contrasting very strikingly with similar sections of skin discoloured by the mere subsidence of the blood.

It is scarcely necessary to add that redness follows instantly on the application of heat, and that vesicles show themselves after the interval of a few seconds.

SPONTANEOUS COMBUSTION.

The following case, which rests on the authority of Le Cat, a firm believer in the doctrine of spontaneous combustion, forms a fitting introduction to this subject. It is said to have taken place in 1725:—

One Millet, living at Rheims, was charged with the murder of his wife, whose body was found lying in the kitchen near the hearth, entirely consumed. Part of the head, portions of the lower extremities, and a few of the vertebræ, had escaped combustion. The floor beneath the body was partially burnt. The prisoner

* This case is quoted by Chambert in an elaborate paper in the 'Annales d'Hygiène,' April, 1859, to which the reader is referred.

stated that he and his wife had retired to rest the previous evening,—that she, not being able to sleep, got up and went into the kitchen, as he supposed to warm herself, and that he was roused by the smell of fire, and going down to the kitchen, found the deceased lying near the hearth, in the manner stated. The prisoner was condemned to death, but, on appeal to a higher court, the sentence was revoked, and it was pronounced to have been a case of spontaneous human combustion.

In this case the extent to which the body was consumed gave some support to the opinion, that it was more combustible than human bodies in general, but no countenance to the notion that the fire originated in the body itself. It was certainly in the most favourable circumstances for being *set on fire;* and this is true of most of the cases of alleged spontaneous combustion reported to have occurred in England and abroad.

Orfila testifies his belief in spontaneous human combustion by thus describing the phenomena that accompany it:—A light blue flame appears over the part which is about to be attacked: this flame is not readily extinguished by water, and indeed frequently the addition of this liquid only serves to increase its activity. Deep eschars now form in the part affected, accompanied by convulsions, delirium, vomiting, and diarrhœa, followed by a peculiar state of putrefaction, and death. The process is said to advance with extreme rapidity, but the body is never entirely consumed: some parts are only half burnt, while others are completely incinerated, a carbonaceous, fœtid, unctuous ash remaining. The hands and feet commonly escape destruction, while the trunk is usually entirely dissipated. The wooden and other combustible articles of furniture situated near the individual are either uninjured, or but imperfectly consumed; the clothes, however, covering the body are commonly destroyed. The walls and furniture of the apartment are covered with a thick greasy soot, and the air is impregnated with an offensive empyreumatic odour. This phenomenon is stated to have been chiefly observed in aged corpulent females, and especially in persons long addicted to the abuse of spirituous liquors.

It is, perhaps, practically of little consequence whether the doctrine of *spontaneous* combustion be true or false. The cases on record (Jacobs, as cited by Casper, has brought together 28, of which 20 occurred in France) may be fairly allowed to prove an unusual combustibility of the body, occurring in rare instances and, for the most part, in corpulent spirit-drinking females, merely requiring to be set on fire, and needing no other fuel but their clothes, night-dress, or ordinary bed-furniture. Till we possess

cases better authenticated, and more accurately reported, we must content ourselves with this amount of knowledge, not forgetting, meanwhile, that such men as Liebig and Casper treat the very notion of spontaneous combustion as an idle fable, stamped with the brand of sheer credulity, and one opposed to such simple facts, among others, as that the human body contains 75 per cent. of water.

The spontaneous combustion of inorganic substances is a subject of much interest and importance, but it has no medico-legal bearing.

DEATH BY LIGHTNING.

From the Reports of the Registrar-General for the five years 1852–56, it appears that about 21 deaths by lightning occur, one year with another, in England and Wales; 18 in males and 3 in females. This mode of death rarely gives rise to medico-legal questions; but inasmuch as the effects sometimes produced on the body, both external and internal, resemble those caused by mechanical violence, a question might possibly arise, whether a person found dead, under unknown circumstances, had perished from the effects of lightning, or had been murdered.

In most cases we have a clue to the cause of death in the fact that a thunder-storm has taken place near the spot on which a body is found. This being ascertained, we should next inquire what probability there was of the body having been struck by lightning.

As a general rule it may be stated, that the electric fluid prefers and seeks out good conductors; and as the human body is a very good conductor, it is as likely to be struck as any object similarly situated, unless, perhaps, that object be of metal.

As a general rule, too, lofty objects are more likely to be struck than low ones; but this rule is subject to many exceptions, for persons have been struck in the immediate neighbourhood of lofty trees which have been uninjured.

The electric fluid is often conducted to the body by lofty objects in its proximity, such as trees, masts, and rigging of ships, and the moist strings of kites. The danger of remaining under a tree during a storm is proverbial.

It has been thought that a person is tolerably safe in an open space far from any object which could attract the electric fluid; but this is an error. The human body may be, in these circumstances, the most prominent object and also the best conductor.

Death may be caused by an electric shock, other than the lightning stroke. This takes place when a cloud near the earth

is negatively electrified, whilst the earth is positive, and the human body becomes the conductor, by means of which the equilibrium is restored. This is called the *ascending* or *returning stroke.*

The violent effects produced by the electric discharge—the disruption of buildings and the removal of parts of them to a distance; the separation of good conductors from bad ones; the fusion of metallic substances; the ignition of inflammable ones; the magnetic properties communicated to articles of iron and steel—are familiarly known.

The *Post-mortem appearances* in bodies struck by lightning are very various. Sometimes no marks of violence are found, and this is said to occur most commonly in death by the *returning stroke.* In other cases the body is bruised or torn at the spot where the electric fluid has entered; occasionally there is merely a small round hole at the point of exit. Extensive bruises are sometimes present, most frequently on the back, the electric fluid appearing to prefer the track of the spinal marrow. Fractures of the bones are rare: they may occur, as Ambrose Paré states, without external wound. A case of extensive fracture of the bones of the skull is related by Pouillet. Marks of burns are not frequent, and probably never occur except when the clothes have been set on fire.

The state of the blood, alleged by some authorities to be fluid, by others to be coagulated; the state of the limbs, asserted by some not to grow rigid, but by others, with better reason, to be subject to rigidity, and sometimes even to become quickly and excessively rigid; and the putrefactive process, stated by Paré and others to be retarded, but by other authorities to be hastened,—are signs of little medico-legal importance. The state of the body in these respects is worthy of note; but even should it be clearly made out that the blood is fluid, rigidity absent, and putrefaction hastened, these circumstances could not be considered peculiar to death by lightning, for all of them may coincide in other modes of sudden death.

In some cases the state of the objects found upon the corpse, or belonging to it, furnish complete evidence of the cause of death. The clothes may be torn and burnt; the shoes struck from the feet; metallic bodies fused and forcibly carried to a distance; and articles of iron or steel, such as the steel of the stays, or the main-spring of a watch, rendered strongly magnetic.

Cause of Death.—The power of the electric fluid shows itself chiefly through the nervous system, and the cause of death is the shock sustained by it. If a less degree of injury is inflicted, it is

manifested on the brain, spinal marrow, or nerves, in loss of sight, sensation, or voluntary motion, temporary or permanent.

DEATH FROM COLD.

This is an uncommon event in this country, though death by cold and inanition combined is not very rare in severe winters.

The first effect of intense cold is a sensation of numbness and stiffness in the muscles of the limbs and face. This is soon followed by torpor and profound sleep, passing into coma and death.

The effects of cold are manifested partly on the general circulating system, and partly on the circulation through the nervous centres. The effect on the circulation generally is to drive the blood from the surface to the interior of the body, so as to gorge the spleen, liver, lungs, and brain with blood. The genital organs are similarly affected, priapism sometimes resulting from congestion of the penis. The temperature of the blood itself is lowered; the heart contracts slowly and feebly, and the pulse becomes small and thready. The congestion of the nervous centres occasions numbness, torpor, somnolency, giddiness, dimness of sight, tetanus, and paralysis; and the congestion of the brain sometimes occasions a species of delirium, as happened to Edward Jenner, or the appearance of intoxication, as witnessed by Captain Parry and others in the expeditions to the North Pole.

The effect of cold varies in intensity according to sex, age, and strength: the young, the aged, the infirm, persons worn out by disease or fatigue, and those addicted to the use of intoxicating liquors, perish soonest. It would appear, too, that some persons have a great advantage over others in their power of resisting cold—a fact frequently observed by voyagers and travellers in the Arctic regions.

The circumstances which cause the impression of cold on the body to be severely felt, and which give rise to effects not indicated by the thermometer will be understood from the following considerations:—

The body is cooled in three ways—by cutaneous exhalation; by conduction of the air in contact with it; and by radiation.

The *cutaneous exhalation* is increased by dry and diminished by moist air. Hence the body parts with its heat more rapidly in a dry atmosphere. On the other hand the body is cooled by *conduction*, when the air is moist; so that the body is cooled alike by dry cold air and by cold moist air. Cold humid winds lower

the temperature of the body in a very striking degree. A rapid renewal of the air, as in a brisk cold wind, lowers the temperature of the body, both by evaporation and by conduction. The effect of a slight breeze in increasing the feeling of cold was remarkably shown in the expeditions to the polar seas.

Post-mortem Appearances.—The surface is pale, and the viscera of the head, chest, and abdomen are congested. There is congestion of the vessels of the brain, but extravasation does not appear to have been noticed, though death was formerly attributed to apoplexy. In two cases reported by Dr. Kellie, of Leith, there was a large effusion of serum in the ventricles of the brain. The blood in the aorta and left cavities of the heart is stated by Dr. Paris, on the authority of Sir B. Brodie, to be florid. These appearances are not so characteristic as to be conclusive of the cause of death.

DEATH FROM STARVATION.

This is a very rare event; but death from cold in persons insufficiently nourished is not infrequent. Cases of homicide by the deprivation of food, are of occasional occurrence, and the insane sometimes commit suicide by obstinately refusing to take sustenance. Some prisoners under long sentences would starve themselves if not fed by force.

The Symptoms produced by protracted Abstinence are pain in the epigastrium, relieved by pressure; emaciation, the eyes and cheeks sunken, the bones projecting, the face pale and ghastly, the eyes wild and glistening, the breath hot, the mouth dry and parched, intolerable thirst, delirium, and extreme prostration of strength. The body at length exhales a fœtid odour, the mucous membranes of the outlets become red and inflamed, and death takes place in a fit of maniacal delirium, or in horrible convulsions.

Death takes place after a period varying with age, sex, and strength, with the amount of exertion and the supply of water. This latter circumstance is very important, for the experiments of Redi show that animals live more than twice as long with access to water as without it.

Life has been prolonged under voluntary starvation for a considerable period; in one case (that of Viterbi), twenty-one days, and in a case reported by Van Swieten* forty-two days, and in a

* "I knew a woman who obstinately refused all kinds of nourishment for six weeks, drinking nothing but a little water at intervals, so that at length she perished quite juiceless and dried up."—Commentaries upon Boerhaave's Aphorisms—Melancholy Madness.

still more remarkable one, fifty-eight days. This, which occurred in the south of France, and was reported to the Academy of Medicine, is as follows:—

Guillaume Granet, a prisoner at Toulouse, resorted to starvation to avoid punishment. For the first seven days the symptoms were not very remarkable; his face was flushed, his breath foul, and his pulse small and feeble. After this period he was compelled to drink water occasionally, to relieve the excessive thirst which he suffered, but in spite of the close watch kept over him, he frequently drank his urine, or the water of the prison-kennel. His strength did not appear to fail him during the greater part of the time, and, with varying symptoms of constitutional disturbance and acute sufferings, he lingered till the fifty-eighth day, when he expired, after struggling four hours in convulsions.*

Of the prolongation of life under the fatigues, exposure, total privation of food, and want of fresh water (except such as may have been supplied by dew or rain) incidental to shipwrecks, we have some well authenticated cases. A narrative of a shipwreck on the Calcutta coast which has been placed at my disposal shows that out of 13 men without food or water 12 days, three died, the rest escaped, and recovered. And a very detailed and evidently faithful account of the picking up at sea of Captain Casey, commander of the *Jane Lowden*, timber vessel, shows that out of 18 men, including the captain himself, wholly without provisions and fresh water, one survived 11 days, one 12 days, one 14 days, two 15 days, one 18 days, and the captain himself 28 days. Two men appear to have died early furiously delirious, one (a lad, æt. 19) who died on the 12th day, was quietly delirious, with spectral illusions; two others were delirious, and Captain Casey had illusions of hearing.†

Post-mortem Appearances.—The body is much emaciated, and exhales a fœtid odour; the eyes are red and open, the skin, mouth, and fauces dry, the stomach and intestines empty and contracted; the gall-bladder is distended with bile; the heart, lungs, and large vessels are collapsed, and destitute of blood; and putrefaction runs a rapid course. These appearances are not so characteristic as to be decisive of the mode of death; but in the absence of any disease productive of extreme emaciation, such a state of body will furnish a strong presumption of death by starvation. It must be recollected, that there are maladies such as stricture of the œsophagus, and organic disease of the stomach, which prove fatal by starvation. Search should, therefore, be made for such causes of death.

* Foderé, vol. ii. p. 276. † The 'Times,' February 7, 1866.

The post-mortem appearances were faithfully described by Mr. Biggs in a case of murder by starvation and exposure: that of Mark Cornish, starved by his father and step-mother.* He stated at the coroner's inquest that the deceased was so wasted that he had scarcely any muscle left, and no fat; that he looked like a skeleton with the skin tightly stretched over him; that he could not only see each bone but its peculiarities; that all the organs were healthy, though the heart and stomach were small; that the *omentum* was as clear as glass; that there was no food in the stomach, and that the small intestines were nearly empty; and that there was no appearance of chyle.

The time that a person may remain without food, or may support life on a very scanty supply of it, may become a question of some importance, as will appear from the case of Elizabeth Canning, quoted by Dr. Cummin in his Lectures in the 'Medical Gazette,' vol. xix. The question raised in this case was, whether a girl of eighteen could be confined, in the depth of winter, twenty-eight days, without fire, with about a gallon of water in a pitcher, and with no food but some pieces of bread, amounting altogether to about a quartern loaf, and a small minced pie which she happened to have in her pocket, and at the expiration of the period retain sufficient strength to break down a window-shutter fastened with nails, get out of the window on to a sort of pent-house, thence jump to the ground, nine or ten feet below; and finish by walking from Enfield Wash to Aldermanbury.

To this question we could not but return an answer in the negative. The cases which have been alluded to, and especially that of Guillaume Granet, give us good ground for believing, that life might have been prolonged for twenty-eight days, or even more, on this scanty supply of nourishment; but it is extremely improbable that, at the end of this time, she would have had strength enough left to effect her escape. This case is also curious in its bearing on the question of identity.

The longest abstinence from food, with free access to water, of which I have had experience among prisoners, is ten days. In two men and one woman complete abstinence from food during this period was followed by no bad symptom, and the ordinary prison diet was resumed without injury to health. The prisoners were weakened, but by no means exhausted. In the case of ten days' starvation of a prisoner reported by Casper, scarcely any liquid was taken, and the exhaustion was much greater.—(Handbook, vol. ii. p. 28.)

* 'Morning Chronicle,' February 26, 1853.

PART III.

TOXICOLOGY.

The frequent occurrence of cases of real or supposed poisoning, and the complicated nature of the questions to which they give rise, render this not only the most interesting, but the most important division of Forensic Medicine; while the great number of recognised poisonous agents causes it to occupy no inconsiderable part of every medico-legal treatise.

Before proceeding to treat of the Poisons in detail, certain questions relating to poisons and poisoning in general will have to be discussed, such as the definition of the word poison, the mode of action of poisons, the causes which modify their action, and the classification of which they are susceptible.

It will also be necessary to point out the means we possess of answering the many questions which present themselves for solution when a suspicion of poisoning has been raised, and we are required to determine whether it is well or ill founded. Under this head we shall have to discuss the inferences that may be drawn from the origin and progress of the symptoms which gave rise to the suspicion; the value and significance of post-mortem appearances when death happens; and the light which may be thrown upon the case by experiments upon animals, by chemical analysis, and by the conduct of suspected persons.

Again, the precautions which ought to be observed in conducting post-mortem examinations in cases of suspected poisoning, and those equally important which should be borne in mind in the several steps of a chemical investigation, ought to be very carefully examined and explained.

These leading divisions of the subject of poisoning will be treated, with some detail, in three separate chapters, being so many departments of the principal subject of Poisons in General.

CHAPTER I.

DEFINITION OF A POISON: ACTION AND CLASSIFICATION OF POISONS.

1. *Definition of a Poison.*—The *meaning* which ought to attach to the word poison is best ascertained by a simple process of exclusion. A substance which affects one person in consequence of peculiarity of constitution, but has no effect upon others, is not a poison: a substance which owes its effect to some temporary condition of system, as when cold water is swallowed by a person heated by exercise, is not a poison: substances which mechanically injure and inflame the internal parts, such as pins and needles, and particles of steel or glass, are not poisons: again, hot water being merely a vehicle for conveying heat, is not a poison. Substances, therefore, which owe their action to some peculiarity of constitution, or unusual condition of the body; as well as mechanical irritants, and harmless substances rendered injurious by extraneous causes, are not properly termed poisons. Nor does the mode of application to the body form any part of the definition of the word poison. It may be applied to the skin, or inhaled, or swallowed, or introduced into the anus or vagina, or into the ear, but it is still a poison. Again, the quantity of a given substance that may prove fatal, or the time required to destroy life, cannot be allowed to enter into the definition; for in both these respects undoubted poisons differ widely from each other. Lastly, the form of the substance or matter, whether solid, liquid, or gaseous, must be held to be immaterial. These exclusions have narrowed the possible definition of a poison, so that the following may be accepted as sufficient for every practical purpose:—A poison is any substance or matter (solid, liquid, or gaseous) which, when applied to the body outwardly, or in any way introduced into it, without acting mechanically, but by its own inherent qualities, can destroy life.

In the great majority of cases poisons are swallowed. They are given, "*administered to*," or "*taken by*" the person injured or killed; but they have been introduced into the body through the lungs, rectum, vagina, or ear, and they might be in-

serted into the nostril. They have also been applied to the skin unbroken or abraded. Now though the words *"administer to"* and *"taken by"* are used in §§ 11, 14, 23, 24, of the "Act to consolidate and amend the Statute Law of England and Ireland relating to offences against the person," 24 and 25 Vict. 1861, the word *"apply"* ("apply or administer to") is used only in § 22, in reference to "chloroform, laudanum, or other stupefying or overpowering drug, matter, or thing." It is to be regretted that the same full and explicit phraseology was not employed in all the sections of the Act.

The word "poison" is often qualified by such terms as "active," "virulent," "deadly," and the last of these terms is very generally used in indictments.

A "deadly poison" may mean one which is fatal in a small dose, or kills quickly in a larger dose, or which, irrespective of the dose, is more dangerous or difficult to counteract than others. Strychnia and oxalic acid, for instance, are both "deadly poisons;" but while less than a grain of the one may destroy life, about half an ounce of the other is a fatal dose; yet a full dose of oxalic acid may kill much more quickly than even a large dose of strychnia. On the other hand, the fatal dose of Epsom salts or sulphate of potash is two or three ounces, and even those quantities would not prove certainly or rapidly fatal: so that it would obviously be incorrect to call these substances "deadly poisons." Nor would the term be correctly applied to such a substance as sulphate of zinc, which is often prescribed as an emetic in doses of a scruple or half a drachm, or to the non-corrosive preparations of mercury, iron, or copper. In any case the term "deadly poison" is open to the objection of raising an unnecessary verbal question, and when used in indictments should be treated as mere "legal surplusage," in accordance with the wise dictum of Mr. Justice Erle.

"A destructive thing," a phrase also used in the statute just referred to, if not a poison properly so called, must be some substance, or matter, which kills by a mechanical action on the internal parts, or by some adventitious property, such as heat. Particles of glass or steel, by irritating the lining membrane of the alimentary canal; and pins and needles, by wounding vital organs, or inflaming less important parts, may be fairly regarded as "destructive things;" but whether the term would properly apply to such matters as sponge, or plaster of Paris, which may destroy life by blocking the passage of the intestines, may admit of doubt.

Having defined the term "poison" with sufficient precision to

indicate the matters which will have to be examined in the following pages, certain general questions relating to poisons must next be considered. These are,—*Their mode of action*, and *The causes which modify their action.*

2. *Mode of action of Poisons.*—This is twofold, *local* and *remote.* Their *local* action may consist in *corrosion,* or chemical decomposition, as when a strong acid, a pure alkali, or a corrosive salt, is applied externally or taken internally: in *inflammation,* followed by adhesion, suppuration, ulceration, or gangrene, when such irritants as arsenic, tartar-emetic, or cantharides, are similarly taken or applied: and lastly, in an effect on the nerves of sensation or motion. The numbness and tingling of the lips, tongue, and throat, occasioned by chewing monkshood, the sharp pricking sensation in the tongue caused by the arum maculatum, and the numbness of the skin which ensues on the application of prussic acid, chloroform, or veratria, are instances of local action on the nerves of sensation; while the palsy, due to the direct application of opium, ticunas, or prussic acid to the muscles, the dilatation of the pupil from the application of belladonna, and its contraction under the use of the Calabar bean, illustrate the same local action on the muscular fibre.

The *remote* action of poisons is also twofold, *common* and *specific.* Their *common* effect is that which would result from any severe injury inflicted on the same part; their *specific* effect is such as the poison alone can produce. The two effects, or modes of action, may be noted in the symptoms caused by such a poison as arsenic, which when swallowed, and so applied to the lining membrane of the alimentary canal, gives rise to the same cramps in the extremities which are present in cholera, English and Asiatic, and in all acute inflammations of the same membrane; but the same poison, inserted into a wound, applied to the skin, or inhaled, inflames the mucous surfaces with which it does not come into immediate contact. This is its specific action. Again, oxalic acid, which acts on the stomach as a corrosive and violent irritant, causes the same constitutional shock which accompanies all severe local injuries: this is its remote common effect; but it has also a remote *specific* effect on the brain and spinal cord. The purest example of a remote constitutional effect of a common kind is afforded by the mineral acids, and the alkalis and their carbonates, which, by the local destruction they occasion, give rise to the symptoms of collapse present in extensive burns and scalds. This absence of remote specific effects has led some authors to doubt the propriety of classing those chemicals among poisons.

The remote specific effects of poisons may also be distinguished as *general* and *partial*—that is to say, as producing a general effect on the whole frame, or a partial effect on a particular organ or texture. Tartar-emetic, for instance, has a depressing effect on the system, and a local action on the lungs; while arsenic, which acts as a stimulant to the system, exerts a local action on the mucous surfaces.

A knowledge of the *specific* remote action of poisons is of the first importance, for it often enables us to define the class to which a poison belongs, and even to indicate the very poison itself. Thus, stupor points to the action of some member of the narcotic class; delirium to the class which comprises belladonna, hyoscyamus, and stramonium; paralysis, or great loss of muscular power, might indicate the action of hemlock, tobacco, digitalis, aconite, or the Calabar bean; tetanic spasms would lead us to infer the action of strychnia; arsenic sets up inflammation in the mucous membranes; mercury attacks the salivary glands and mouth; cantharides the urinary system; antimony the lungs; manganese and copper the liver; chromate of potash the conjunctiva; iodine the lymphatic glands; lead the muscular system; phosphorus promotes fatty degeneration; and spurred rye produces gangrene of the limbs. Poisonous substances used in the arts also reveal themselves through their specific actions. Thus the dropped hand betrays the use of lead, paralysis agitans that of mercury, gangrene of the jaws that of phosphorus, and a peculiar rash about the nostrils, ears, bends of the arms, and scrotum, the employment of the arsenite of copper.

These brief statements might lead to serious mistakes if it were not understood that some symptoms which are constant effects of the poisons just enumerated are also occasional symptoms of other poisons. Thus, tetanic spasms, though characteristic of the action of strychnia, may occur in poisoning by morphia and other of the alkaloids, as well as from the action of arsenic, corrosive sublimate, and tartar-emetic. Salivation, again, may result from poisons other than mercury; and the dropped hand is not conclusive of the action of lead, for the preparations of arsenic may occasion it. Nor ought it to be forgotten that these are but the leading phenomena among a considerable group of less characteristic symptoms. Thus the same case of poisoning by arsenic may combine severe irritation of the alimentary canal with inflammation of all the mucous surfaces, a rapid pulse, and a series of acute nervous symptoms. Oxalic acid and the salts of mercury produce similar complications. It must also be understood, that many of the best-marked symptoms of poisoning

are also symptoms of diseases. This fact will be fully illustrated in the section of this chapter which treats of the Evidence of Poisoning.

In producing the remote specific effects just spoken of, poisons must either be carried by the circulation to the parts affected, or their action on the nerves of the part to which they are applied must be propagated to the nervous centres, and thence reflected to the organs remotely affected. Now there is abundant proof of the absorption of poisons, and their circulation through the system, and experiments on animals have shown that this takes place in whatever way the poison is applied or introduced. By the analysis of the blood, secretions, and solid textures, the poisons are further proved to have circulated with the blood; and the list of poisons thus detected includes every substance which can be recognised by its odour or colour, or which, not having been completely decomposed, can be submitted to chemical reagents. The fact of the absorption of poisons is therefore established and admitted; but the question arises—Is the fatal action of poisons due to their absorption? This question will be answered in the affirmative if it can be shown, on the one hand, that poisons continue to act so long as the blood passes freely from the point of insertion to the tissues or organs affected, and that, on the other, their action is stopped or postponed when the circulation is arrested.

The well-known experiment of Magendie, in which a poisoned limb was connected with the body only by quills introduced into its large vessels, and yet the poison continued to act, establishes the first proposition as true of wounds; while one of Mr. Blake's experiments with prussic acid introduced into the stomach through an opening in its walls, the poison producing no effect so long as the vessels passing from the stomach to the liver were secured by ligature, but beginning to act within one minute of its removal,* proves the second proposition as true of poisons that are swallowed. That the great nervous trunks cannot transmit the poisonous influence, is proved by the facts that poisons inserted into a limb connected with the body by nerves only are inactive; that division of the spinal marrow does not prevent the action of those poisons which prove fatal by attacking that part; and that the direct contact of poisons with the substance of the brain itself is innocuous.

It appears, then, that poisons, whether inserted into wounds or introduced into the stomach, act by absorption, and that, when

* 'Ed. Med. and Surg. Journal,' vol. liii. p. 45.

absorption is prevented, and the circulation arrested, they cease to act.

The question now arises—In what way do poisons, circulating through the system, produce their fatal effects? On what tissues and organs do they act?

It is plain that all poisons do not destroy life in the same way. Some paralyse the heart, others act directly on the lungs, and suffocate; a third class attack the brain; a fourth the spinal marrow; and a fifth appear to affect the entire capillary circulation. This difference of action is best displayed when, as in Mr. Blake's experiments, poisons are introduced directly into the current of the circulation. So introduced, the salts of magnesia, lime, strontia, and baryta; of zinc, copper, lead, and silver; with oxalic acid and digitalis, affect the heart; the salts of soda, hydrocyanic acid, tobacco, and euphorbium attack the capillaries of the lungs; opium and its alkaloid, morphia, affect the brain; while the action of the salts of potash and ammonia seems limited to the general capillary circulation.* An ingenious attempt was made by Morgan and Addison to prove that these different modes of death were due to some powerful influence transferred to the organ or tissue affected, through the nerves of the blood-vessels themselves; but an experiment by Mr. Blake, in which blood poisoned with woorara continued to traverse the arteries and veins of the abdominal viscera for several minutes before any effect manifested itself, affords a sufficient refutation of this hypothesis. Important additions have been made to our knowledge of the action of poisons, and of the proximate cause of death in poisoning, by M. Claude Bernard. He has shown by well-devised experiments on animals that the more active poisons kill by attacking particular tissues or organs—that woorara paralyses the motor nerves; that strychnine attacks the sensitive portion of the nervous system, and excites fatal reflex actions; that digitalis, upas antiar, corrowal, and wao, veratria, and several other poisons, act on the muscular tissue throughout the body, and on the heart as a muscle.†

There remains, then, but one explanation of the fatal action of poisons—namely, that they are carried with the blood to the organs or tissues on which they act: some by the coronary arteries to the heart, which they paralyse; others to the spinal marrow, exciting fatal tetanic spasms in the respiratory muscles; others to the brain, proving fatal by an indirect action on the respiration;

* 'Ed. Med. and Surg. Journal,' vols. li., liv., and lvi.
† Lectures in 'Medical Times and Gazette,' 1860, vol. ii. Nos. 532, 3, and 5.

and others, again, to the lungs, arresting the capillary circulation, and killing by suffocation.

This theory, of the necessity of absorption to the action of poisons, had to encounter a difficulty in the rapidity with which certain poisons, such as prussic acid, prove fatal; but this was removed by Blake's ingeniously-contrived and carefully-performed experiments. Having provided a delicate measure of the state of the circulation by inserting into the femoral artery of the animal to be experimented on, the hæmadynamometer of Poiseuille, he introduced directly into the vessels various substances previously known to paralyse the heart, and noted the instant of time at which the first effects of the poison manifested themselves, and at which the heart ceased to beat. He found that a poison passed from the jugular vein to the lungs of a dog in from four to six seconds; from the jugular vein to the coronary arteries of the heart in seven; from the jugular vein to the carotid artery in from five to seven, and from the aorta to the capillaries in four seconds. A poison introduced into the jugular vein was distributed through the whole body in nine seconds. In the horse, the circulation was completed in from twelve to twenty seconds, or somewhat less than the twenty-five seconds deduced by Hering of Stuttgardt from his experiment.

These experiments are confirmed by the more recent ones of Claude Bernard. A saturated solution of sulphuretted hydrogen, introduced into the jugular vein of a dog, began to be eliminated from the lungs in three seconds; and when injected into the femoral vein of the same dog, in six seconds.

The time required for the circulation of a poison through the body of a dog being taken at nine seconds, it follows that if poisons applied to the dog's tongue do not act in so short a space of time, absorption may take place, and the blood may be distributed to the organ on which it produces its fatal effects. Now, Blake found that strong hydrocyanic acid applied to the tongue of a dog did not begin to act till eleven seconds, and did not kill till thirty-three seconds; and when a tube was previously introduced into the larynx, so that the vapour of the acid did not enter the lungs, the first symptoms did not show themselves till sixteen seconds, and death did not take place till after the lapse of forty-five seconds. Nicotine, the essential principle of tobacco, applied to the tongue of the same animal, did not kill till twenty seconds. These experiments would suffice to prove the necessity of absorption to the fatal action of poisons, were it not for the existence of a small group of well authenticated cases in which poisons have destroyed life instan-

taneously, or much more promptly than in any of Blake's experiments. Thus Christison states that an animal has been killed outright by prussic acid in four seconds;* and cases are cited by the same author, and by Dr. Taylor,† in which the same poison killed in three, and even in two, seconds; and in the experiments of Sir Benjamin Brodie, alcohol and the essential oil of bitter almonds seem to have produced the same instantaneous effect.‡

In presence of these facts, and with the knowledge we have of the instantaneous impression, or shock, produced by extensive mechanical or chemical injuries, it must be admitted that the more active poisons taken in large doses may destroy life by a sudden nervous shock.

A fact reported by Sir B. Brodie renders it probable that poisons may act through continuity of tissue. A man was bitten in the hand by a rattlesnake. Inflammation, sloughing, and suppuration of the cellular tissue of the arm followed, and there was copious and extensive extravasation of blood beneath the skin of the chest and back, limited to the injured side of the body.

The theory of absorption finds a practical application in the use of ligatures, cupping-glasses, and lip-suction in the case of poisons inserted into wounds.

3. *The causes which modify the action of poisons* are three in number:—1. *Their quantity and form.* 2. *The part to which they are applied.* 3. *The condition of the body itself.*

1. *Quantity and Form.—Quantity.*—As a general rule, the larger the quantity of a poison the more prompt and the more severe is its action; but when poisons are swallowed, a large dose will sometimes be immediately and completely discharged by vomiting, while a smaller dose will remain on the stomach, and prove fatal. The action of some poisons also varies remarkably in kind as well as in degree with the quantity taken. Thus oxalic acid in a large dose may kill almost instantly by shock; in a smaller dose it may still prove fatal by its action on the heart; in a yet smaller dose it affects chiefly the spinal cord; and in a more minute dose still, the brain. Again, small repeated doses will develop other symptoms than a single large dose. Of the whole class of narcotico-acrid poisons, it may be affirmed, that in large doses they act chiefly on the nervous system, in smaller doses on the alimentary canal.

* 'Treatise on Poisons,' p. 7.
† 'Medical Jurisprudence,' 5th edition, p. 160.
‡ 'Physiological Researches,' p. 139.

Form.—Under this head will have to be considered—*a. State of Aggregation. b. Chemical Combination. c. Mixture.*

a. State of Aggregation.—Solution increases the activity of poisons partly by promoting absorption, partly by bringing them into contact with a larger surface. Soluble poisons therefore are the most active, and soluble salts more active than the less soluble base. Volatile poisons also act with great energy on the lungs and skin.

b. Chemical Combination.—Such poisons as the mineral acids and the alkalis are deprived of their active properties by being neutralized; and, as a general rule, the salt which results from the union of acid and base is more or less active as it is more or less soluble. Acid poisons, in combining with bases, or basic poisons combining with acids, conform to the same rule, and the resulting compounds, if soluble, retain the specific characters of their active ingredient. Thus all the soluble salts of morphia have the same action; and the same is true of all the soluble compounds of oxalic acid. When two poisonous substances combine (as arsenious acid with copper, or prussic acid with mercury or silver), the resulting compound may give rise to the symptoms of the more active, to the mixed effects of the two, or to symptoms peculiar to itself. Lastly, some poisons insoluble in water, as arsenite of copper, and carbonate of lead or baryta, may be rendered soluble and active by the acid juices of the stomach, or by the secretions of the skin.

c. Mixture.—All admixtures which render a poison more soluble make it more active: all others have a contrary effect. Thus acids increase the activity of opium, and of the salts of copper, and water of arsenic; but on the other hand, oily, mucilaginous, albuminous, and starchy liquids retard the action of poisons by protecting the coats of the stomach, by involving the poison, if in substance or powder, or even by acting as antidotes. Hence the frequent escape of those who have taken large doses of arsenic or corrosive sublimate with, or directly after, food. Much also depends on the character of the food. Thus arsenic in a solid dumpling would manifest its effects much more slowly than in porridge, and in porridge than in the liquids in common use. So also with poisons when given as medicine. Strychnia in a pill would act more slowly than in a mixture. We avail ourselves of the protective effect of the thick liquids just mentioned in the treatment of cases of poisoning; and we administer substances possessed of little power as antidotes, because they have the property of withdrawing and holding in suspension certain poisons. Powdered charcoal is the

best example of this class; and magnesia and the sesquioxide of iron owe their repute, as antidotes to arsenic, chiefly to this property.

2. *The Part to which the Poison is applied.*—The effect of a poison on different parts of the body is directly as their absorbing power. Thus poisons act most promptly when inserted into a wound; the serous surfaces hold the next place; then the stomach; and, last of all, the unbroken skin. Injection into a vein insures the quickest action; but volatile poisons introduced into the lungs act with nearly as great rapidity as when introduced thus directly into the circulation. The corrosive poisons and stronger irritants produce an effect proportioned to the importance of the part to which they are applied. Thus, the mineral acids prove speedily fatal when they attack the windpipe; less speedily when they act on the gullet and stomach, and they must destroy a large surface of skin in order to kill quickly. Many animal poisons, such as the poison of the viper or mad dog, introduced into the system in minute quantity, by puncture of the skin, kill very quickly, though the same small quantity, and even a much larger dose, may be swallowed with impunity.

3. *The Condition of the Body itself.*—Under this head will have to be considered—*a. Habit. b. Idiosyncrasy. c. Disease.*

a. Habit.—No broad general rule can be laid down in reference to the influence of habit. For while some vegetable poisons, such as opium, alcohol, and tobacco, lose their effect by repetition, and may at length be taken in doses which would poison a man not accustomed to their use, other poisons belonging to the same classes, as digitalis and strychnia, have a cumulative effect. Again, though the less deadly mineral poisons, such as the sulphates of zinc and iron, may be taken by healthy persons in continually increasing doses, arsenic, mercury, and phosphorus, when used in the arts, and gradually introduced into the system, appear, like the carbonate of lead, to be more dangerous the longer they are used. Nor do men and women who work with arsenite of copper grow more tolerant of the poison. The same effects are reproduced at each resumption of their employment. The stomach may, however, become accustomed to poison, and grow nearly insensible to it, as happens with the spirit-drinker. It should, however, be borne in mind that even those poisons to which the system most readily adapts itself, produce permanently injurious effects. Thus alcohol causes disease of the lungs, liver, kidneys, and brain; tobacco quickens the pulse; and opium injures the digestion, emaciates the body, and enfeebles the mind.

b. Idiosyncrasy.—Peculiarity of constitution may be shown in

two ways—1. By a greater or less susceptibility without difference of action. Thus, a few grains of mercury shall salivate one man, but as many drachms or ounces shall not affect another. 2. By exceptional action. Thus, Epsom salts have been known to act like opium, and opium to have a purgative effect; and a simple article of diet, which is the daily food of other men, shall act like a poison on a few individuals. Thus, certain kinds of meat, fish, and vegetables act like irritant poisons on some persons. Even mutton has been known to act invariably in this way.

c. Disease.—This, as a general rule, renders the body less susceptible of poison. Thus, patients reduced to extreme weakness by fever or other causes, are scarcely affected by stimulants which would overpower the strong. In continued and in yellow fever there is increased tolerance of mercury, but in paralytic affections, and anæmic states of system, an opposite condition prevails; in anæmia, large doses of preparations of steel are readily borne; and in severe dysentery, cholera, and hæmorrhage, large quantities of opium; in all the more severe affections of the nervous system, every remedy, but especially the narcotic poisons, may be given in greatly increased doses. Delirium tremens may be safely and successfully treated by half-ounce doses of tincture of digitalis, and opium may be given in one form of mania in repeated doses of two scruples. The only exception to the general rule is in the case of poisons which tend to produce symptoms similar to those actually existing. Thus, the irritants would increase gastritis, diarrhœa, or dysentery; and the narcotics exasperate a determination of blood to the brain, or an attack of uræmia.

There is still one condition of system which deserves mention as tending to impair the effect of poisons—viz., sleep. In this state all the functions are carried on more languidly, and the body is less alive to the action of medicines and poisons. This is true of sleep artificially induced, so that narcotic poisons given with or before other poisons, must weaken or counteract their effects. Opium, for example, when given with arsenic, not only masks the symptoms proper to that poison, but appears to retard its operation.

4. *Classification of Poisons.*—There are only two principles of classification which commend themselves to the judgment as logically sound and practically useful. The one arranges the poisons according to their source, the other in accordance with their action on the system. When the first principle is adopted, poisons are arranged as inorganic and organic; or in three leading classes—mineral, vegetable, and animal; when the second is preferred, it is usual to arrange them also in three classes—irritants, narcotics,

and narcotico-irritants. The first classification is open to the obvious objection that though almost all the poisons from the mineral and from the animal kingdoms are irritants, those from the vegetable kingdom comprise, in addition to simple irritants, a great number of poisons which, under any conceivable arrangement, must be distributed into many distinct groups. On the other hand, a classification based on the mode of action of poisons is subject to the inconvenience of separating from each other poisons derived from the same kingdom of nature, and, for that reason, presenting analogies and contrasts of chemical composition which render their juxtaposition extremely convenient.

By no possible classification, therefore, can we reconcile the conflicting requirements of physiology and natural history, or satisfy those who seek in all such arrangements for an expression of the highest attainable scientific accuracy. But those who see in classification rather an instrument of convenience than an expression of abstract truth, will be ready to acquiesce in any grouping which brings into closest contact those objects that can be best studied when they precede or follow each other, and concerning which, when so placed, certain general principles can be laid down. The scheme which best fulfils these conditions will be set forth and explained when some of the existing classifications have been described and examined.

The division first proposed by Foderé into *irritants*, *narcotics*, *narcotico-acrids*, and *septics*, rests on a physiological basis, as does also the more generally accepted triple division which excludes the last, and retains the other three. But the best toxicological writers have grown dissatisfied with the third group of narcotico-acrids, as offending against every sound logical principle, and have endeavoured to reconstruct the classification of poisons on a sound physiological basis. The most ambitious, but least successful, attempt is that of Tardieu;* that of Casper is scarcely an improvement upon it:† the scheme of Dr. Taylor is less open to objection.‡ But after carefully examining these schemes, and the juxtapositions to which they give rise, we prefer to adopt a classification that forms a convenient compromise between the claims of physiology and natural history. We first divide the whole body of poisons into *inorganic* and *organic*, and then distribute each into

* 1. Irritants et corrosifs. 2. Hyposthénisants. 3. Stupefiants. 4. Narcotiques. 5. Nevrosthéniques (p. 167).

† 1. Irritant poisons. 2. Poisons which produce hyperæmia. 3. Nerve-paralysing poisons. 4. Poisons which produce marasmus. 5. Septic poisons (Handbook, p. 44).

‡ 1. Irritants. 2. Neurotics, distinguished as cerebral, spinal, and cerebro-spinal ('Medical Jurisprudence,' p. 136).

appropriate sub-classes: the inorganic into *corrosives* and *irritants;* the organic into *irritants,* and such as destroy life by their action on the *brain, spinal cord, heart* and *lungs* respectively. The irritation of the alimentary canal which marks the action of so many of the organic poisons, and which justifies the use of the term *narcotico-acrid,* will be considered as subordinate to the more important effect produced on the nervous centres, on the heart, or on the lungs. The classification, as far as it is necessary to explain it in this place, will therefore be as follows:—

Poisons.

1. Inorganic.
   - *a.* Corrosive.
   - *b.* Irritant.
2. Organic.
   - *a.* Irritant.
   - *b.* Affecting the brain.
   - *c.* " " spinal cord.
   - *d.* " " heart.
   - *e.* " " lungs.

The two leading classes of inorganic and organic poisons figure in the bills of mortality for 1852–6 as causing respectively 77 and 191 deaths out of the 268 due to poisons distinctly specified. 133 deaths caused by poisons not identified, being added, makes up a total of 401 deaths as ascertained to have been produced by poison on the average of those years. It will be seen that out of 100 poisons proving fatal, 29 would be inorganic, and 71 organic. The most important poisons of the two classes are shown by the following figures:—*Inorganic:* arsenic 27, salts of lead 23, mineral acids 15, salts of mercury 10. *Organic:* laudanum, opium, morphia, and Godfrey's cordial 141, prussic acid, essential oil of bitter almonds, and cyanide of potassium 34, oxalic acid 13, strychnia and nux vomica 2.

Before dismissing the subject of classification, it may be well to point out some of the results of the plan now adopted as compared with that preferred in former editions of this work. Oxalic acid, which followed the corrosive mineral acids, and resembled them in the destructive effects of its stronger solutions, is now grouped with prussic acid, which it as nearly resembles in the promptness of its action and marked effect on the nervous centres. From the class of irritants, which comprised cantharides and its active principle, cantharidine, and hellebore with its alkaloid veratria, these two important poisons, with some others, are removed to the organic group, in which will now be found every active principle of organic origin; so that these principles may now be treated as their great importance demands, with a view to their discrimination the one from the other: and the inorganic poisons can be similarly treated with like advantage. The illustrations of the poisonous plants will also be found side by side under a common heading.

CHAPTER II.

EVIDENCE OF POISONING.

UNDER the title at the head of this chapter it is usual to examine the circumstances which would lead us to infer that some poison has been taken. Among these circumstances those which contribute most directly to the formation of an opinion are the *Symptoms and post mortem appearances; experiments on animals; chemical analysis; and conduct of suspected persons. Valuable evidence may also be afforded by the symptoms and post-mortem appearances proper to the different classes of poisons.*

1. *Symptoms.*—In most cases of poisoning the symptoms appear suddenly, in a person in good health, soon after taking food, drink, or medicine; and in most fatal cases, death happens in a few minutes, hours, or days.

The sudden appearance of the symptoms affords a presumption in favour of poisoning; for, when given in full doses, poisons act promptly. On the other hand, when given in small and repeated doses, the invasion of the symptoms may be gradual. It must also be recollected that many diseases of the vital organs—the brain, heart, and lungs—perforation of the stomach or intestines, and severe epidemic maladies, such as plague, cholera, and yellow fever, continued fever, the febrile exanthemata, small-pox, scarlatina, and measles, set in suddenly with severe symptoms of indisposition.

The occurrence of the symptoms in a person in good health, also affords a presumption in favour of poisoning; but as many acute diseases suddenly attack healthy persons, and many sudden deaths occur in persons apparently in rude health, too much stress must not be laid upon this sign. It should also be borne in mind that poisons are sometimes given to persons already suffering from illness, and that in other instances the health is slowly undermined by repeated doses of some less active substance, such as tartar emetic, and death suddenly brought about by a deadly poison, such as morphia, strychnia, or veratria. Witness the French case of Castaign, and the English cases of Palmer, Dove, Pritchard, and others.

The appearance of the symptoms soon after taking food, drink,

or medicine, affords a stronger presumption; for the more active poisons given in large doses act with great promptitude. But, on the other hand, it must be recollected that vomiting and other symptoms of indisposition may set in after a wholesome meal; that a full meal is also a common precursor of apoplexy; that rupture of the coats of the stomach, softened by previous disease, naturally takes place while the organ is distended with food; that English cholera may be caused by unripe fruits, putrid meat, or other unwholesome ingesta; and that a large draught of cold water swallowed while the body is heated, may produce instant death.

The presumption afforded by the symptoms occurring soon after a meal is greatly strengthened when other persons partaking of the same meal are similarly affected: but too much importance should not be attached to the absence of such effects in others; for the person in whom the symptoms have shown themselves may have partaken of some dish, or part of a dish, or of some wine or drink, which the others had not tasted.

The attack of several persons by similar severe symptoms, soon after a meal of which all have partaken, affords the strongest possible presumption of poisoning either by the food itself, or by some accidental or intentional admixture. If the symptoms are those of simple irritant poisoning, we cannot determine by the symptoms alone which of these alternatives is the true one; but they may be so characteristic as not only to prove the administration of a poison, but to indicate the very poison itself.

The simultaneous fatal attack of several persons in the same place, or on the same mission, in the absence of proof that they had partaken of the same food, would also furnish a strong presumption of poisoning. Thus, the death in one night of four of the eight peers selected to represent the Scottish nation at the nuptials of Queen Mary with the Dauphin of France, in 1558 (Lord Fleming at Paris, Bishop Reid, the Earl of Rothes, and the Earl of Cassilis at Dieppe) certainly justified the suspicion of poisoning, for which the refusal of the Scottish deputies to grant the crown matrimonial to the bridegroom had furnished a motive, by giving great offence to the French Court.*

A suspicion of poisoning is often successfully rebutted by the fact that no food, drink, or medicine had been taken for hours before the commencement of an illness attributed to a quickly acting poison. The inference would be somewhat weakened if sleep had occurred in the interval. In this place it may be well

* Sharpe's 'Peerage'—Marquis of Ailsa.

to advert to the fact that poisons have been introduced into the anus or vagina, poured down the throat of a drunken or sleeping person, or inserted into the ear; and that the hypodermic method of administering active medicines is not unlikely to be resorted to by the better informed class of poisoners.

The rapid course of the symptoms towards a fatal termination affords but a weak presumption of poisoning; for many cases of poisoning end fatally after a considerable interval, and many acute diseases run a very quick course.

All the characters now mentioned are, therefore, to be received with caution, and carefully weighed. The joint occurrence of two or more of them would afford a strong presumption; and the coincidence of all, though not decisive, would justify a very strong suspicion. Thus, if a person in perfect health, soon after taking food, were attacked with severe and continued vomiting and purging, and died within twenty-four hours, a strong suspicion would naturally arise that the food had contained some poisonous substance; and the suspicion would be greatly strengthened if other persons who had partaken of the same food were similarly affected. The food itself might have had poisonous properties or the poison might have been added to it; but the probability of poisoning in one of these two ways is very strong; and the inference would be almost irresistible if it could be shown that the person affected had never suffered in the same way before, and that neither English nor Asiatic cholera was prevailing at the time.

2. *Post-mortem Appearances.*—There are certain poisons and classes of poisons which leave in the dead body unmistakeable signs of their action. Mineral acids stain and corrode the parts with which they come into contact, and oxalic acid in strong solution, as well as one or two mineral corrosive poisons, corrode the lining membrane of the gullet and stomach. Other poisons leave on the lining membrane of the stomach very characteristic deposits. Thus corrosive sublimate, decomposed by the secretions and membrane of the stomach, as well as by its albuminous contents, leaves a slate-coloured deposit of finely-divided mercury; and arsenious acid in substance often forms a white patch clinging to the inflamed membrane, which may be changed into the yellow sulphide by sulphuretted hydrogen, the product of putrefaction. Orpiment and Scheele's green, cantharides, and nux vomica, and the spores of poisonous mushrooms, also leave a coating of characteristic colour; and phosphorus betrays itself by shining in the dark. Vegetable poisons, too, are sometimes identified by seeds, or fragments of leaves left in the alimentary canal.

Other poisons, again, whether inorganic or organic; both those which have a simple irritant action, and those formerly classed as narcotico-acrids, excite an inflammation in the stomach and intestines more intense than that due to disease. A less degree of inflammation, being common in the alimentary canal of those who die a natural death, would not justify a suspicion of poisoning; and the same remark applies to those appearances of congestion in the brain which are common to the action of the narcotics and narcotico-acrids, and to many diseases and disorders of the brain.

Considerable importance naturally attaches to the negative evidence from post-mortem appearances. Thus the absence of corrosion in alleged cases of poisoning by corrosives, and of inflammation, after the alleged administration of an irritant or narcotico-irritant poison, would render the charge of poisoning highly improbable. The absence of congestion of the brain, in a case of imputed narcotic poisoning, would afford a lower presumption.

The absence of characteristic post-mortem appearances might also become important in the very improbable event of poison being introduced into the body after death, with a view to inculpate an innocent person.

Formerly undue importance was attached to unusual blackness or lividity of the skin, and to the early occurrence of putrefaction as evidence of poisoning. But there is no reason to believe that these appearances are more common after death by poison than after other forms of sudden or speedy death; and it is now well known that some of the mineral poisons—for instance, arsenious acid, corrosive sublimate, and chloride of zinc—preserve the parts with which they come in contact.

Post-mortem appearances similar to those produced by poison, even though confirmed by the discovery of the poison itself, would not prove that death has been caused by poison, for it might be due to some cause anticipating its fatal action. On the other hand, a dead body may bear marks of severe external injury, or extensive disease of the internal organs, and yet the real cause of death be poison.

The post-mortem appearances, then, though they furnish conclusive independent evidence in the case of several poisons, afford only a slight presumption in a still larger number; but even when inconclusive in themselves, they may strengthen, by their presence, the presumption drawn from symptoms, or from moral evidence, or, by their absence, they may invalidate a charge prompted by malice.

3. *Experiments on Animals.*—These are very valuable both as affording evidence of poisoning, and as illustrating the mode of operation of poisons. Experiments intentionally made, confirmed by happy accidents (as when domestic animals and poultry have partaken of the same food as the poisoned person, or have eaten the matters rejected from his stomach), have shown that the dog and cat, as well as poultry, are killed by the poisons which prove fatal to man, and that they die with symptoms similar to those by which he has suffered; and when, as in poisoning by prussic acid, and strychnine, the effects of the poison are quickly developed and symptoms of a very marked character are present, the evidence from this source must be admitted to be conclusive. But even in the absence of any previous experience of the effect of poison on a healthy living creature, the death of such creature soon after the administration of a poison which is believed to have proved fatal to a man, affords the strongest evidence in favour of poisoning, even without taking into account the character of the symptoms. On the other hand, should the animal neither suffer nor die, the presumption in favour of the harmlessness of the substance under trial is very strong. When the substance supposed to contain poison is so abundant that it can be given to different animals, or when the matters rejected from the stomach happen to be eaten by them, the death of all the animals in question affords undoubted proof of poisoning.

In rare cases of poisoning of animals by arsenic or strychnia, good evidence has been afforded by the fatal effect on other animals of eating their flesh.

The value of the evidence from experiments on animals is affected by one or two considerations arising out of the discrepant effects of the same poison on different living creatures. It has been ascertained beyond all doubt, that there is at least one insect that can feed and flourish on strychnia; and nearly half a century ago M. Runge, of Berlin, fed a rabbit exclusively for no less than eight days on the leaves of belladonna, hyoscyamus, and stramonium, and found the animal at the end of the time as healthy as at the beginning; and this though M. Runge found that the poisonous principles had been taken up into the animal's body. There was not even any dilatation of the pupil. Dr. W. Ogle, in a letter addressed to the *Times* in August, 1865, applies this fact to the case of Mr. Sprague, tried for attempting to poison the Chalker family, and acquitted; and deems it probable that the belladonna found its way into the poisoned pie through the flesh of a rabbit which had fed on the plant. This explanation must be admitted to be quite feasible, for it has been well as-

certained that poisonous plants which prove harmless to insects, birds, and animals that use or consume them, may impart to the secretions and flesh of the creatures in question properties highly poisonous to human beings. Thus, the honey of bees collected from the calmia azalea and rhododendron, and even the mead made from it, has been found poisonous. During the famous retreat of the 10,000 under Xenophon, the army suffered severely by eating the honey collected from the azalea pontica. The milk, as well as the flesh, of cattle browsing on some of the herbage in South America has proved poisonous. The flesh of hares that had eaten the rhododendron chrysanthemum, that of pheasants that had fed on the buds and shoots of the calmia latifolia, and that of partridges that had partaken of certain berries during the Canadian winter, and had been imported into this country packed in ice, have proved poisonous; and as lately as September, 1862, Mr. F. Taylor, of Romsey, reported two cases of great severity from eating the Canadian partridge, and the case of a cat sickened and paralysed by the same cause. Some time since, several persons near Toulouse were poisoned by a dish of snails which had been fattened on the leaves and shoots of coriaria myrtifolia.*

It may be safely conceded, therefore, that certain poisons belonging to the vegetable kingdom may be consumed with impunity by insects, birds, and animals, and yet the honey collected by bees, the flesh of birds, and the milk and flesh of animals, if consumed by human beings, may occasion distinct, and dangerous, and even fatal, symptoms of poisoning.

To the evidence drawn from experiments on animals, with matters rejected from the human stomach, or collected from the stomach and intestines after death, it has been objected that the animal secretions may be so vitiated as themselves to prove poisonous, and the objection has been enforced by a well-known experiment of Morgagni. The bile from the stomach of a child, who died in convulsions from tertian ague, mixed with bread and given to a cock, caused convulsions and death in a few minutes, and the same effect followed in two pigeons inoculated with it. But it is obvious that experiments with the bile of a diseased subject can have no proper application to cases in which food rejected from a healthy stomach has proved poisonous to animals.

It is scarcely necessary to state that the negative result of experiments with substances rejected from the stomach, or found there after death, is not conclusive against poisoning, for the

* 'Med. Times and Gaz.,' Sept. 13, 1862.

poisonous substance may have been evaporated, decomposed, absorbed, or previously rejected.

When there is reason to believe that we are dealing with a small quantity of poison, small animals, such as rats or mice, should be chosen for experiment; or the frog, as particularly adapted for experiment with minute quantities of such poisons as strychnia. Leeches have also been suggested as applicable to the same purpose. The hypodermic method of administering such active medicines as morphia and conia will evidently admit of extension to the identification of poisonous substances, as soon as sufficient data have been collected by well-devised experiments similar to those described by Dr. John Harley in his Gulstonian lectures given at the College of Physicians (1868). Those who desire to follow up this class of experiments should select for their purpose one animal, and by preference the dog.

In experimenting on larger animals that vomit their food, with poisons which act speedily, the rejection of the poison from the stomach should be obviated by securing the gullet with a ligature.

The necessity of experiments on animals is now very generally superseded by chemical analysis; but as the tests for some of the vegetable poisons are uncertain, such experiments, performed with care, are valuable, and have been admitted as evidence.

When experiments on animals are resorted to, in order to illustrate the mode of operation of poisons, or to determine some important question, such as the shortest time within which a dose of prussic acid may prove fatal, or the possible absence of marks of inflammation in the stomach after poisoning by some irritant, which usually occasions them, such as corrosive sublimate, choice should be made of the dog, as the animal of which, as the subject of toxicological experiments, we have the largest experience.

4. *Chemical Analysis.*—This form of evidence, though not absolutely necessary when the symptoms, post-mortem appearances, and circumstantial evidence confirm each other, or even when two of the three presumptions coincide, is always of the first importance. The poison may be discovered in the living person by tests applied to the urine, to the blood abstracted by bleeding, cupping, or leeches, or to the serum of a blistered surface; or it may be detected in the dead body in the blood, flesh, viscera, and secretions. In both these cases the discovery of the poison affords conclusive evidence of its administration.

When we have to deal with substances rejected from the stomach or voided by the bowels, or with the contents of the stomach and bowels after death, or with food or medicine of

which the sufferer has partaken, the evidence is obviously less conclusive, for objections may be raised on each of the three suppositions, that poison has been detected, that it has not been detected, or that it has been found in very small quantity.

On the supposition that a poison *has been found* in the matters discharged during life, or found in the alimentary canal after death, or in articles of food or medicine, there is the one objection, that it may have been accidentally mixed with it, or fraudulently, in order to inculpate an innocent party; in which case the evidence must be supported by proof that this could not have happened.

On the supposition that a poison *has not been found* in any of the substances submitted to analysis, it does not follow that none has been taken; for, in the case of a meal actually containing poison, and followed by symptoms of poisoning, the articles submitted to analysis may not contain the poison, though some other portion of the meal may. The poison may even be so unequally distributed through a single dish that the part examined may not contain it, though other parts of it do. The poison may be in the gravy, and not in the meat, or it may have been sprinkled only on the outside of the joint. Again, we may fail to detect poison in the contents of the stomach and intestines, because it had been rejected, or evacuated, absorbed, decomposed, or evaporated; or because it belongs to that large class of vegetable poisons which we have not yet found the means of discovering with certainty. Poisons are most likely to be rejected or evacuated when they belong to the class of irritants, absorbed when they are in a fluid state or soluble, decomposed when they belong to the animal or vegetable kingdom. Poisons which are insoluble, or sparingly soluble, such as arsenic, may often be detected in the stomach, and sometimes in the intestines, after repeated vomiting and purging, for they adhere to the mucous coat, being glued to it by the tenacious products of inflammation.

When the examination of the body is delayed, and in cases of disinterment, we may fail to discover a poison which actually existed in the body at the time of death, from its having exuded through the textures, evaporated, or been completely decomposed. This observation does not apply to mineral poisons; for though subject to change by the decay of the textures, they are transformed, not destroyed. Thus arsenious acid may be converted into the yellow sulphide, and corrosive sublimate into the black sulphide of mercury, or by contact with the mucous membrane be changed to calomel, or deposit finely divided mercury.

Among animal poisons, cantharides, and, among vegetable poisons, strychnia, may be mentioned as undergoing little change from the decay of the textures.

It is scarcely necessary to add that malicious or mistaken imputations of poisoning may be shown to be unfounded by the non-discovery of poison in the matters supposed to contain it.

When poison is found *in very small quantity*, the objection is sure to be advanced that the quantity so found was not sufficient to account for death; but it is met by the obvious reply that the quantity of poison found must needs fall short of the quantity actually taken: for it is always only a part of the matters vomited or otherwise expelled from the body, of the contents of the alimentary canal after death, or of the blood tissues or viscera of the body, which is submitted to analysis. The discovery, therefore, of a quantity of poison insufficient to destroy life is scarcely even a presumption that the substance was not administered in a poisonous dose; though it is consistent with the supposition that the poison was given as a medicine.

But the value of chemical analysis as evidence of poisoning is not limited to the discovery of a poison in some single substance submitted to examination; for by comparing one analysis with another, important light is sometimes thrown upon the mode of administration, and the innocence or guilt of a suspected or accused party. A bowl of porridge eaten at breakfast by a female believed to have died from poison was found to contain arsenic. The chemical analysis showed that the poison was not mixed with the store of meal, but only with the portion used in making the porridge; and as other circumstances justified the inference that the poison had been mixed with the meal in the morning before any stranger entered the house, the husband (the only other inmate) was convicted of the murder. In a case of an opposite kind arsenic was found mixed with a large mass of flour, as well as with the part used in making bread. It was accordingly inferred that the flour had been ground from wheat intended for seed, mixed with arsenic to destroy insects, and sent, in mistake, to the mill.*

In several cases of poisoning by corrosive acids, the clothes of the suspected murderer have been stained in the same way as the clothes and body of his victim.

The cases just referred to are examples of *qualitative* analysis. The value which may sometimes attach to *quantitative* analysis is shown by the two cases which follow.

* Cases quoted from Alison and Barruel by Christison. 'On Poisons,' p. 75.

Mr. Hodgson, a surgeon, was tried at Durham Autumn Assizes, in 1824, for attempting to poison his wife. He had substituted corrosive sublimate for calomel in pills containing opium, prescribed by her physician, but this he attributed to a mistake committed while intoxicated. It was also proved that a laudanum draught, ordered by her physician, contained corrosive sublimate; but this, too, he explained by alleging that he had mistaken for the water-bottle an injection of corrosive sublimate previously prepared for a sailor. But on submitting the draught and the injection to chemical analysis, the former was found to contain fourteen grains, while the latter contained only five grains, to the ounce.*

Samuel Whalley was indicted at York Spring Assizes, in 1821, for administering arsenic to Martha King, who was pregnant by him. But it appeared that, of the tarts in which the arsenic was alleged to have been administered, the portions eaten could not have contained more than ten grains, while the matters alleged to have been vomited, contained, even after repeated attacks of vomiting, fifteen grains.

5. *Conduct of suspected persons.*—Great importance is very properly attached, in trials for poisoning, to the conduct of the prisoner, before, during, and after the illness of the deceased. He is often proved, without adequate motive, to have made a study of poisons and their properties; to have purchased poison under false pretences; to have compounded medicine, or prepared food for the deceased; to have sought opportunities of administering medicine or food; to have made himself the sole attendant on the deceased; to have hastily disposed of matters which might have been examined; to have placed obstacles in the way of obtaining proper medical assistance; to have kept near relatives, and other inconvenient witnesses at a distance; to have made hurried arrangements for the funeral; to have made opposition to an examination of the body; to have tampered with the matters reserved for analysis. Such acts as these, some of which are likely to fall under the notice of a medical attendant, will have to be carefully weighed by the jury, together with such other items of general or circumstantial evidence as point to the existence of an obvious motive or inducement to the crime, or indicate the previous state of mind of the deceased, as affording a probability, or the reverse, of suicide.

6. *Symptoms and post-mortem appearances proper to the different classes of poisons.*—The foregoing observations will be understood to apply to poisons in general. The symptoms and

* For a full report of this interesting case see the 'Edin. Med. and Surg. Journal,' vol. xxii. p. 438.

post-mortem appearances proper to the principal classes of poisons will now be described, both as giving completeness to the present chapter, and as supplying information applicable to the special poisons both of the inorganic and organic divisions. There are two classes of poisons which present both symptoms and post-mortem appearances of a well-defined character—the corrosives and the irritants—and a third class, divided into important sub-classes, according as they affect the brain, the spinal cord, the heart, or the lungs, in which the symptoms are well marked, but the post-mortem appearances less constant, the alimentary canal being subject to like uncertainty of action and post-mortem appearance. This third class formerly comprised the two distinct divisions of narcotics and narcotico-acrids. These several classes will now be briefly passed under review.

a. Corrosives.—This class of poisons is characterized, as the name implies, by their destructive action on the parts with which they come in contact. If they were to act on a large extent of the cutaneous surface, they would destroy life as burns and scalds of like extent and severity. When swallowed, they prove fatal by the same destructive action on the lining membrane of the alimentary canal, or of the windpipe, the immediate causes of death being shock, exhaustion, perforation of the stomach or intestines, starvation from stricture of the gullet, or extensive destruction of the secreting membrane of the stomach, and in rare cases occurring chiefly in young children, suffocation from injury to the glottis and windpipe. These effects are produced, among inorganic poisons, by the mineral acids, and the caustic alkalies and their carbonates, among the organic poisons by strong solutions of oxalic acid, and of tartaric and citric acids. In the group of inorganic poisons there are also several corrosive soluble salts (chlorides) of the metals mercury, antimony, zinc, and tin, which combine with their direct corrosive action remote specific effects in addition to those due to the corrosion itself.

The *symptoms* due to these poisons are very well marked. A burning pain, with a strong acid, alkaline, or metallic taste, is felt as soon as the poison comes in contact with the parts. It occurs almost simultaneously in the mouth, throat, gullet, and stomach, whence it extends rapidly to the entire abdomen, is soon followed by vomiting, and after no long interval by purging. The matters discharged contain blood, either pure, or acted upon by the poison. The epiglottis and upper part of the windpipe are often corroded, so as to occasion suffocation and speedy death.

The *post-mortem appearances* are those of corrosion, mixed with corrugation from strong contraction of the muscular fibres,

and followed by inflammation and its consequences. The corrosions may be confined to small spots, or may extend over a large surface; they may be limited to a removal of portions, more or less considerable, of the lining membrane of the gullet and stomach, or they may destroy all their coats, so as to occasion perforations large or small, and the discharge of considerable portions of the organs themselves (as well as of casts of them resulting from the action of the acids on their secretions) by vomiting or by stool. Beyond the corroded parts, the textures are acutely inflamed, sometimes gangrenous, often black from blood extravasated into the cellular tissue beneath, or injection of the vessels with dark blood. Sometimes the tissues are found softened, sometimes hardened and shrivelled. These poisons often produce in the gullet a peculiar wrinkled and worm-eaten appearance, due to the contraction of the longitudinal and transverse fibres, and the removal of patches of epithelium. (See figs. 68, 69, and 70, p. 408.)

As these effects of the corrosive poisons may possibly be mistaken for post-mortem appearances due to other causes, it may be well to point out more particularly the characters by which the one may be distinguished from the other.

Softening of the mucous membrane due to the corrosives is attended by changes of colour arising, in the case of the mineral acids, from their direct action on the tissues, in the case of corrosive sublimate, from the deposit of the finely divided metal or its sulphide. In the case of some other corrosive poisons we are not assisted by these changes, but must be guided by the state of the gullet, and the action on the skin and clothes. The *hardened and crimped* state of the parts with which the corrosive comes in contact is eminently characteristic, as it is never present in disease. The black injection of the vessels is not conclusive, inasmuch as it may be produced by the action of any acid liquid or acid secretion of the stomach itself. *Gangrene* is a rare result of disease, and the black infiltration into the sub-mucous tissue for which it is sometimes mistaken is equally uncommon. *Ulceration* and consequent *perforation*, as the result of the action of the corrosives, is to be distinguished, in the case of most of them, by characteristic colours; and this is true both of small ulcers and of extensive destruction of the tissues. The characters of ulcers from disease will be presently described, when speaking of irritant poisons. That extensive destruction of the coats that sometimes arises from the action of the gastric juice after death belongs to this place.

The destructive action of the gastric juice after death was

formerly a subject of controversy; but the fact of its sometimes taking place has been placed beyond a doubt, by observations in man and experiments on animals. The usual seat of the opening is the posterior surface of the stomach, but it varies with the position of the body. The aperture may be as small as a shilling or as large as the palm of the hand: and it has even been found to occupy one-half of the stomach. It may assume any shape, and its edges are fringed, softened, and smeared with a dark pulpy mass; and the vessels of the stomach are often found injected with dark blood—a common action, as already stated, of acid fluids. The neighbouring viscera sometimes undergo a similar change. Occasionally there is more than one aperture. As there is no inflammation around the opening, it is not possible to confound this post-mortem change with the effect of an irritant poison, which would be attended by marks of acute inflammation, and by characteristic stains and deposits. When the gastric juice acts only on the mucous membrane of the stomach it gives it a soft gelatinous appearance of a black or dark brown colour.

Perforation of the *intestines* is very rare in cases of irritant poisoning, and perforation of the *gullet* still less common. Both may occur from diseases not difficult to recognise after death.

b. Irritant Poisons.—Substances that inflame the parts to which they are applied are said to act as irritants to those parts; and those which produce the same effect on the alimentary canal are also termed irritants; and, with the exceptions indicated when defining the term *poison*, of hot and cold water, and such articles as pins, needles, and powdered glass, may claim to be admitted into the list of irritant poisons, if they prove in any instance fatal to life, or productive of symptoms of great severity.

The class of irritants comprises mineral, animal, and vegetable substances; it contains a greater number of individual poisons than all the remaining classes put together; and it also contributes largely to the list of cases of poisoning. It accounts for nearly one-fourth (63 in 268) of the annual deaths from ascertained poisons; of which the great majority (61 in 90) were metallic irritants.

Of this considerable class two groups admit of distinction and separation; one, the members of which destroy life by the irritation they set up in the parts to which they are applied, the other, by adding to local irritation peculiar or specific remote effects. To the first group belong the principal vegetable irritants, some of the alkaline salts used in medicine, the less active metallic poisons, some products of destructive distillation, and the irritant gases. The second group comprises the metallic irritants,

arsenic, mercury, antimony, lead, and copper; the metalloidal elements, phosphorus, and iodine; and one product of the animal kingdom, cantharides.

The *symptoms* caused by irritant poisons, as a class, are burning pain and constriction in the throat and gullet; sharp pain, increased by pressure, in the pit of the stomach; intense thirst; nausea and vomiting, followed by pain, tension and tenderness of the entire abdomen; and purging attended with tenesmus, and frequently with dysuria. The constitutional symptoms vary with the intensity of the irritation, and the interval which has elapsed since the administration of the poison, being at one time those of collapse, at another of inflammatory fever. The mode of death also varies. One patient will not rally from the first shock to the nervous system; a second dies in strong convulsions; a third worn out by protracted suffering; a fourth starved through the permanent injury inflicted on the gullet and stomach.

These symptoms vary in severity, and in the time and order of their occurrence, with the quantity of the poison, its solubility, and the full or empty state of the stomach. When the poison is sparingly soluble, as is the case with arsenious acid, the pain and sense of constriction in the throat and gullet are not felt immediately on swallowing it, but after an interval more or less considerable, and, occasionally, they are absent; or they follow the other symptoms instead of preceding them, in consequence of frequent acts of vomiting, and the repeated contact of the dissolved or suspended poison with the upper portions of the tube. The stronger and more soluble irritant poisons cause the discharges from the stomach and bowels to be mixed with blood, which happens rarely, and to a more limited extent, in the case of the simple irritants; and they sometimes inflame the upper part of the windpipe, giving rise to hoarseness, wheezing respiration, and harassing cough, occasionally ending in suffocation.

The post-mortem appearances caused by the irritants are those of inflammation and its consequences.

The simple irritants give rise to inflammation more or less severe, followed by its usual consequences. In some cases there is merely increased vascularity, in others deep redness; and the surface may be coated with a tenacious secretion, and the cavity filled with a glairy mucus. The coats may be found thickened through the intensity of the inflammation; black from bloody extravasation into the submucous tissue; ulcerated, gangrenous, and sloughing; softened; but occasionally hard and shrivelled. Vessels filled with dark blood are sometimes found ramifying minutely over the surface, which in other instances is studded

with black points. These appearances are not confined to the stomach, but are found in the fauces, and gullet, and in the duodenum. The rest of the small intestines is often the seat of acute inflammation, with ulceration and softening of the mucous membrane; ulcers are also found in the large intestines, and excoriation of the anus. In some cases the lining membrane of the larynx and air passages is inflamed.

Several of these symptoms and post-mortem appearances are not peculiar to poisoning; for one or more of them are present in English and Asiatic cholera, in acute inflammation of the stomach or bowels, in rupture of these parts, or of other viscera of the abdomen. They may also be produced by drinking hot or cold water; and authors have been at some pains to show that simple distension of the stomach, vomiting and purging of blood, colic, strangulated hernia, obstruction of the bowels, diarrhœa, and dysentery, have some symptoms in common with ordinary cases of irritant poisoning, and may still more nearly resemble certain exceptional cases. Though some of the objections founded on this possible resemblance of disease to poisoning are of little force, it may be well to point out some of the leading features in which the diseases in question differ from the usual effects of irritant poisons.

In *English cholera*, the evacuations very rarely contain blood, and there is no pain and constriction in the throat, though there may be some soreness as the result of constant efforts to vomit. The disease prevails chiefly in summer and autumn, and is rarely fatal. In *Asiatic cholera*, too, discharge of blood is a very rare occurrence, though the evacuations sometimes have a port-wine tint; and the pain and constriction of the throat are wanting. In both diseases the purging follows the vomiting much more rapidly than in cases of poisoning. There is one group of cases of poisoning by arsenic, in which the symptoms so nearly resemble those of the two forms of cholera, that medical men have fallen into error without seriously affecting their reputation. *Acute inflammation of the stomach*, except as the result of drinking hot or cold water, or as the effect of some irritant substance not esteemed poisonous, is very rare, and is not attended by pain and constriction of the throat, or by diarrhœa. *Acute inflammation of the bowels* affects their peritoneal covering, and is attended with constipation. *Distension of the stomach*, though an occasional cause of severe suffering and of sudden death, does not admit of being mistaken for the effect of a class of poisons of which vomiting is a leading symptom. Indeed, a full stomach is in itself the strongest possible presumption against irritant

poisoning. *Rupture of the stomach* occurring, as it often does, during or directly after a meal, and through an effort to vomit, followed by sudden and violent pain, by collapse, and by death instantly, or in from four or five to less than twenty-four hours, might naturally raise a suspicion of poisoning, which nothing short of a post-mortem examination could set at rest. The same observation applies to rupture of the inner coat alone (a very rare occurrence) and to *rupture of the intestines or other viscera of the abdomen*, all which accidents may be followed by vomiting, with excruciating pain, and extreme tenderness of the abdomen, cold skin, feeble pulse, and symptoms of collapse, with death within twenty-four hours. The effect of drinking *hot water* differs from that of the simple corrosives, chiefly in the absence of characteristic stains, and the negative result of an analysis. The drinking of *cold liquids* sometimes causes vomiting and purging, and other symptoms allied to those of irritant poisoning; and, in the absence of a complete history of the case, it may be necessary to resort to the negative evidence afforded by the result of an analysis.

Of *vomiting and purging of blood* it will be sufficient to remark that they are not accompanied by urgent symptoms suggestive of the action of poison; of *diarrhœa* and *dysentery* that, in the great majority of cases of poisoning discharges from the bowels are associated with vomiting; and of *colic, strangulated hernia*, and *obstruction of the bowels*, that they are attended by constipation, and that the vomited matters are often feculent.

The *post-mortem appearances* in irritant poisoning are not always characteristic; and it is true of the more common appearances, as of some of the more usual symptoms, that they may be occasioned by disease. Those usually specified are *Redness, Gangrene and Lividity, Softening, Ulceration, and Perforation, of the mucous membrane.*

Redness of the mucous membrane may be produced by colouring matter: but when it is due to blood contained in the vessels, it may be traced to subsidence after death; to repletion of the small vessels by the contraction of the large arteries; to transudation through the peritoneal covering of the liver or spleen; to congestion in cases of sudden death, especially if caused by apnœa, when it often occurs in large bright patches; or lastly, it may result from the flow of blood to the stomach which takes place during digestion. Sometimes, too, a remarkable redness of the stomach is found after death without any symptoms having occurred during life to account for it. Hence, mere redness of the mucous coat of the stomach is not to be regarded as a proof

of inflammation; but when it is combined with softening, putrefaction not having set in; when the membrane itself is covered with a thick and tenacious mucus; when it is opaque, so that when dissected off it hides the finger over which it is stretched, the redness may be certainly attributed to inflammation; and the same remarks apply to the intestines.

Gangrene and Lividity.—*Gangrene* of the mucous membrane is a well-known consequence of obstructed circulation in cases of hernia, and of internal constriction, and authors of reputation have described it as a consequence of acute inflammation; but it is probable that the dark appearance caused by infiltration of blood blackened by acid secretions has been often confounded with it.

Lividity.—When this occurs as a minute injection of the vessels with black blood (figs. 70 and 71, pp. 408 and 409), it may be the result of the action of an acid introduced from without, or generated within the body; and it can be produced after death by pouring any of the mineral acids into the intestines. Lividity then, or blackness, of the membrane, when it is not caused by gangrene, is an appearance not directly due to disease, but the effect of some acid, swallowed or secreted. The blackness sometimes met with in the intestines in acute dysentery and enteritis, if not gangrenous, is probably due to the same cause. The deposit of black pigment known as melanosis, is distinguished by being arranged in regular well-defined spots, without thickening of the membrane, or signs of surrounding inflammation.

Softening.—The mucous membrane may be softened or hardened by the action of poisons, or by the result of inflammation caused by them, or it results from disease. But it is a very common effect of the action of the gastric juice after death. As that occasioned by the non-corrosive irritants is attended by marks of acute inflammation, the true cause will be readily recognised; and the fact that morbid softening is not preceded by any characteristic symptoms will greatly assist the diagnosis.

Ulceration.—Ulcers of the stomach may arise from disease, or from the action of poison. The former are the result of cancer of the stomach, which is readily recognised, or they occur in stomachs which, in other parts, present a healthy appearance. Open ulcers, or the scars of ulcers, are present in about one dead body in ten, and in about one-fifth of the cases there is more than one ulcer. The ulcer is rarely much smaller than a fourpenny piece, or larger than a crown, but it may attain a diameter of five or six inches. It is usually round or oval; and presents the appearance of a shallow but level pit, with a sharp, smooth, vertical edge, as though it had been punched out; and as the

opening in the sub-mucous areolar tissue is smaller, and the aperture in the peritoneum, if the ulcer perforates, still more minute, it has the appearance of a cone, with the base directed inwards. The mucous membrane and the areolar tissue are somewhat thickened by exudation of lymph; and it is not unusual to find adhesions to surrounding parts. In some cases there is little or no appearance of inflammation around the ulcer; in most the edges are thickened and raised, and the thickening may extend to a circle of half an inch or an inch; and sometimes the surrounding parts are described as "a thick brawny mass," or as being blackened. These appearances have been mistaken for cancer. More than a third of the ulcers occupy the posterior surface of the stomach, and more than three-fourths either that part, the lesser curvature, or the neighbourhood of the pylorus. The ulcers caused by poisoning are the result of a more intense inflammation; and they are often found discoloured, as in the case of poisoning by nitric acid and iodine; or covered with a white powder, as in the case of poisoning by arsenic; or coated with the decomposed poison, such as the black powder (minutely divided mercury), formed by the decomposition of corrosive sublimate, or the yellow sulphide of arsenic formed during the process of putrefaction after death.

Perforation of the Stomach may arise, 1, from corrosion; 2, from inflammation, followed by ulceration; 3, from softening during life; and 4, from the action of the gastric juice after death.

1. *Perforation from Corrosion.*—It is impossible, as already stated, to confound a perforation due to the direct *corrosive* action of an irritant poison with any perforation arising from natural causes acting either during life or after death. The state of the mouth, throat, and gullet, and often of the skin and clothes of the deceased, renders the distinction easy; and in many cases the contents of the stomach or bowels escape into the cavity of the abdomen, and leave traces of their action on other viscera.

2. *Perforation from Ulceration* is very rare. When caused by idiopathic inflammation, the surrounding mucous membrane is less highly inflamed, and neither stained nor covered with deposit, as in poisoning by the irritants.

3. *Perforation from Softening* of the coats of the stomach during life is not a rare occurrence. It most frequently happens in young females, from fifteen to twenty-five years of age, and often after slight symptoms of indisposition. The rupture generally takes place soon after a meal, more rarely as a consequence of sudden exertion, and it is instantly followed by acute pain of the

abdomen, and symptoms of acute inflammation of the peritoneum. There is little vomiting, and no purging, but the patient dies in a state of collapse in from eighteen to thirty-six hours; but in some cases the fatal event is postponed, the stomach being nearly empty, so that the inflammation is of limited extent, or subacute in character. The opening in the peritoneum is generally small, and the ulcer has the peculiar characters just described. In one-third of the cases the perforation has been in the lesser curvature; in one-tenth, at the pyloric extremity; in about one-twentieth, on the posterior surface; in the same number, at the cardiac extremity; while in one-eighth of the cases two ulcers have been found opposite each other on the anterior and posterior surfaces of the organ, the first being the seat of the perforation.* The absence of marks of acute inflammation, and of characteristic discolorations; the non-detection of poison in the stomach, or in the contents of the abdomen; the sudden occurrence of pain in the belly as the first symptom; the slight vomiting; and the absence of diarrhœa, make the distinction between this form of perforation and that due to poison easy.

4. The destruction, and consequent *perforation caused by the gastric juice after death*, has already been spoken of at p. 356.

The poisons which are neither corrosives nor irritants, or which, if they act in either of these ways, prove fatal by their effect on the nervous centres, and, through them, on the brain, heart, or lungs, were formerly comprised under the two heads of *narcotics* and *narcotico-acrids*, oxalic acid (a corrosive in strong solution) being the principal exception. These two classes are now more conveniently treated in different sections according as their most obvious and striking symptoms, when given in full doses and acting in their usual manner, are those of the brain, spinal cord, heart, or lungs. These will be designated, for the sake of convenience as affecting the *brain, spinal cord, heart,* and *lungs,* respectively. To obviate all possible misunderstanding, it may be well to repeat that this arrangement is based on some notable prevailing symptom or group of symptoms, not upon the precise *modus operandi*, or proximate and real cause of death.

1. The poisons which affect the *brain* may be conveniently distributed into three leading sub-classes: one considerable group, of which *opium* is the type, causing sleep more or less profound; a second, of which *belladonna* is the type, producing delirium, with illusions; and a third, of which *alcohol* is the type, giving rise

* Consult Brinton 'On the Pathology, Symptoms, and Treatment of Ulcer of the Stomach;' and Taylor's essay in 'Guy's Hospital Reports,' No. 8.

to exhilaration followed by delirium or sleep, or both successively or alternately, according to the dose and the constitution of the individual.

The group of poisons of which opium is the most conspicuous member owes its importance less to the number of individuals which it comprises (for they are few), than to the habitual use made of them by large classes of persons, their constant employment in the treatment of medical and surgical maladies, the many accidents to which they give rise, and the many occasions on which they are employed by the suicide and murderer. Opium and its preparations alone are taken in nearly half the cases in which the poison can be identified.

The poisons of this sub-class present difficulties which do not occur in the case of irritants. Their symptoms more nearly resemble those of disease, and the post-mortem appearances are often very indistinct, and, even when best marked, not highly characteristic. The chemical analysis also is less sure and satisfactory than in the case of irritant poisoning. The *symptoms* proper to this class are giddiness, headache, dimness of sight, extreme contraction of the pupil, noises in the ears, drowsiness and confusion of mind, passing into insensibility more or less complete. Delirium is rare, and paralysis, convulsions, and tetanic spasms only of occasional occurrence. There is no direct irritation of the stomach and bowels, but nausea and vomiting may occur, not at the commencement (as in the case of irritants) but when the patient begins to recover. Diarrhœa, also, is a rare incident. The *post-mortem appearances* consist in fulness of the veins and sinuses of the brain, effusion of serum beneath the membranes, at the base, or into the ventricles; and, in a few cases, extravasation of blood.

There are several diseases of the nervous centres which, in common with opium and its preparations, have coma more or less profound, and insensibility more or less complete, as prominent symptoms. Apoplexy, cerebral effusion and turgescence, hydrocephalus, blows and injuries of the head, febrile affections in certain stages, uræmia, the close of an epileptic fit, exposure to extreme cold, and many poisons in certain stages of their action, are attended by a profound sleep, from which the patient is not easily roused, or even with coma and insensibility. The diagnosis of disease and poisoning during life will, therefore, sometimes be difficult, especially in infants and young children; and after death the appearances of the brain may prove inconclusive. The discovery of disease of the kidney would furnish a probability of uræmia, and inflammation or chronic disease of the brain, or any

considerable collection of serum upon or within it, would supply a sufficient explanation of death.

The sub-class of poisons, of which belladonna is the best example, is strongly characterized by delirium, spectral illusions, and a largely dilated pupil, with dryness of mouth and throat, and thirst, without any characteristic post-mortem appearance. Tetanic spasms, heightened sensibility, paralysis of the motor and sensitive nerves, coma, and insensibility, are among the exceptional symptoms. But great difference in degree, and strange varieties in the combination of these elements are observed in different cases of poisoning by the same substance.

It must be borne in mind that the delirium which is the leading symptom of the group is also a symptom often present in fevers and febrile disorders, and generally in diseases or injuries attended or followed by fever. Illusions also which are present in this form of poisoning are occasioned by many different, and by some trivial, causes.

The diagnosis of poisoning and disease in this sub-class will rarely present any difficulty. The poisons of this class owe their active properties each to one well-defined active principle (atropia, hyoscyamine, daturia), but they are commonly taken in the form of leaves, berries, seeds, or root; and these, or portions of them, may often be identified in the contents of the alimentary canal rejected during life or found there after death. When symptoms of intestinal irritation are added to the other symptoms, it is to such solid matters that they owe their existence, and not to these active principles.

The third sub-class of poisons, of which alcohol is the type, is characterized rather by the succession or combination of the symptoms which they occasion, than by any one dominant symptom. Excitement of circulation and of the cerebral functions, passing into muscular weakness, shown by want of power as well as by want of co-ordination of movement and by double vision, and this into profound sleep, coma, and insensibility, constitute the usual group and succession of symptoms. Excitement followed by somnolency, and excitement culminating in maniacal violence, are not uncommon occurrences.

The more chronic form of poisoning by this class is characterized by tremor, delirium, and illusions, and the other symptoms of the disease known as *delirium tremens.*

It should be borne in mind that the ordinary effects of alcohol may show themselves as a result of the action of extreme cold, and that they are sometimes present in the early stages of some mental disorders. In the diagnosis of this class of poisons we

are often greatly assisted by the presence or absence of the odour of the poison in the breath of the patient.

2. The poisons which affect the *spinal cord* consist chiefly of strychnia and the plants that yield it. The tetanic spasms which it occasions constitute the leading symptom and sign of their action, and these are present also in tetanus, traumatic and idiopathic, and, exceptionally, as one of several symptoms, in poisoning by many of the more active narcotic poisons of every class. The differences between poisoning and disease will be indicated elsewhere.

3. The poisons which affect the *heart* kill either by sudden shock, or by syncope or collapse less rapidly induced. The first division comprises hydrocyanic acid and the substances that contain it, and oxalic acid and its salts. The second embraces aconite, digitalis, tobacco, lobelia inflata, and hemlock, and some poisons of less importance. A knowledge of their characteristic symptoms may be important in cases of sudden and speedy death. In the case of hydrocyanic acid we are happily greatly assisted by its characteristic odour; in poisoning by oxalic acid by its corrosive action on the gullet and stomach; and in that of aconite by the peculiar effect which it produces on the lips, tongue, and palate.

4. The poisons which act on the lungs, and so destroy life, have for their type carbonic-acid gas, which occasions the symptoms and post-mortem appearances present in death by apnœa, however occasioned. The operation of this class may have to be distinguished from apnœa produced by other causes; and it should be well understood that in poisoning by many of the more active poisons, and notably by prussic acid in doses short of a quickly fatal one, life may be destroyed by a remote action on the lungs producing fatal apnœa.

CHAPTER III.

METHODS OF PROCEDURE IN CASES OF POISONING.

The facts and discussions of the preceding chapter have prepared the way for that more direct examination of the duties required of the medical man in cases of alleged poisoning which it is the object of this chapter to ascertain and set forth.

Suspicions of poisoning may arise in many ways, and under very different circumstances. They may spring up in the minds of persons ignorant of the nature and action of poisons, suggested by some severe illness, or sudden or speedy death, coupled with the suspicious conduct of some relative or friend; or they may occur to the medical man himself during his attendance on a patient; or, again, they may be the utterly groundless fancies of a person of unsound mind, such fancies constituting the leading feature of his malady, or one only of its many delusions. But, in whatever way the medical man may be brought to entertain and consider a suspicion of poisoning, it must be an advantage to him to be supplied with a summary of the points to which, as connected with the symptoms of poisoning, his attention should be directed. The following is such a summary of the leading circumstances to be attended to, and noted down:—

1. The state of the patient before the commencement of the symptoms, whether in good health or suffering from illness—the time at which the symptoms began, and at what interval after a meal, or after taking food, drink, or medicine—their nature, and order, and time of occurrence, and the period of the commencement of any new symptom or train of symptoms; whether the symptoms increased steadily in severity, or alternated with intervals of ease, and whether the exacerbations corresponded with a repetition of food or medicine, or followed the use of any new article of food or medicine—also the character of any substances which may have been rejected from the stomach, or passed from the bowels. The exact time of the death should be noted down, and if the person is found dead, the time at which he was last seen alive.

2. If the symptoms of poisoning have shown themselves soon after a meal, minute inquiries should be made as to the manner in which the several dishes have been prepared; the vessels used in the preparation of the food should be inspected, and their contents, if necessary, preserved; suspicious powders or liquids found in the house should also be sealed and kept. If several persons have partaken of the same meal, care should be taken to ascertain what articles were taken by those who suffered, and by those who escaped, and in what quantities, and whether the same articles of food had been previously taken without any bad effect by the persons attacked.

3. The vomited matters must be carefully collected, and removed from clothing, furniture, &c., on which they had been rejected; and portions of the dress, furniture, or flooring may, if necessary, be reserved for examination.

But suspicions of poisoning may first occur to the medical man during the performance of a post-mortem examination, or he may be required to make such an examination in consequence of suspicions having already arisen in the minds of relatives, or in the course of an inquiry in the coroner's court. In certain cases, too, he may be required to conduct at the same time the disinterment and the post-mortem examination of a body supposed to contain poison. Hence the importance to the medical man of being furnished with a like summary of rules and suggestions to guide him in this important and responsible duty.

Having observed the precautions insisted on at p. 228 as common to all post-mortem examinations for legal purposes, certain other precautions proper to cases of suspected poisoning will have to be taken. These arise out of the well-known fact that while poisons themselves, as well as their most notable effects, are to be found in the alimentary canal, they, and certain of their secondary effects, are to be sought after in the organs and tissues into which they are carried by the blood. The alimentary canal and the principal viscera or parts of them, and, in some cases, portions of muscle, will also have to be preserved for the minute examination and chemical research of the person making the inspection, or of some skilful chemist to whom they must be forwarded.

Prior to the inspection, one large glass or earthenware wide-mouthed jar, and a few smaller ones, should be got ready, which, if not new, should be repeatedly washed out with water and drained, so as to be quite clean. They should be furnished with clean ground-glass stoppers, or with new corks, or other non-metallic means of closure. The larger jar is for the intestinal

canal and its contents, the smaller for the other viscera, or parts of them. The method of procedure, as far as it relates to the intestinal canal, must be governed by such considerations as the following:—When the poison is a corrosive its effects are to be looked for chiefly in the mouth, tongue, throat, windpipe, gullet, stomach, and upper part of the small intestines, and, in case of perforation, in the contents of the peritoneum. If, however, the poison belongs to that considerable class of irritants which combines local action with remote specific effects, we may find not only marks of its direct action on the stomach and small intestines but on the whole intestinal canal, and exceptionally on the gullet; and the viscera to which it is carried by the circulation may also become inflamed, as well as those which are engaged in the work of elimination, especially the kidney and urinary organs, and the glands of the large intestines. In poisoning by opium, alcohol, chloroform, hydrocyanic acid, and the alkaloids, the local effects will be limited, perhaps, to the stomach and upper part of the intestines, but the poisons first named may be found in the serum of the brain. Lastly, animal or vegetable poisons taken in substance, whether as leaves, roots, fruit, or seeds, or as powder, may be found in any part of the alimentary canal. Considerations such as these will determine the parts to be examined, as well as those which ought to be reserved for further examination and analysis. In every case, the whole length of the intestinal canal should be carefully inspected, and especially the gullet, the stomach, and upper part of the small intestines, the cæcum, and the rectum; and these parts with their contents, subject to exceptions arising out of the foregoing considerations, should be reserved. As it is obvious that the condition of the whole of the intestinal canal ought to be ascertained at the earliest moment, the examination on the spot must be so conducted as not to interfere with the more minute examination and chemical analysis afterwards to be made. Accordingly the stomach should be first secured by ligatures at the lower end of the gullet and upper end of the duodenum, and then drawn out and placed in a large clean plate or dish (such as is used by the photographer being the best for the purpose). It should then be slit up from end to end in the line of the lesser curvature, its contents inspected and emptied into one of the jars, and the surface of the organ itself carefully examined, and the ligatures removed. Double ligatures should then be applied at points of the gullet and small intestines where the characteristic appearances end, and the parts divided between them. The organ, with these parts attached, is then to be placed in one of the jars. The cæcum, with some inches of the lower part of

the small and upper part of the large intestines, should be treated in the same way, as well as such other parts of the canal as exhibit marks of inflammation or peculiar appearances of their contents. In the case of the corrosive poisons and stronger irritants, the gullet, with the upper part of the windpipe and the tongue attached, will have to be removed and secured. Of the other viscera, the liver (or part of it), as the organ to which poisons are first carried by the circulation, the kidney as an active organ of elimination, and the heart, as a muscular structure rich in blood, should be reserved; and in cases just indicated the serum of the brain and portions of the organ itself. The urine should also be drawn off for analysis.

The organs and their contents thus reserved for further examination having been placed in separate jars, these must be securely closed by stopper or cork, covered with leather or stout paper firmly fastened round the neck, no sealing-wax, metal, or substance containing metal, being used. Tickets should then be attached, with numbers corresponding to those used in a description dictated at the time of the inspection, and verified immediately afterwards. The several jars should be carefully packed, and the parcel secured by seals. Letters of advice forwarded by post, and all other communications relating to medico-legal examinations in progress, should be doubly secured, first by wafer or gum, and then by seal; and should, if possible, be posted by the writer; all other correspondence being carefully avoided.

That these minute precautions are not wholly unnecessary may be inferred from a fact which came under the cognizance of Tardieu and Roussin: the internal surface of the stomach was found covered to a great extent by the oxide and carbonate of copper in consequence of a large pin having accidentally fallen into that organ after the autopsy.

In cases of exhumation, the character of the soil, the mode of interment, the state of the grave, the condition of the coffin and of the grave-clothes, as well as the position and appearance of the body itself, should be noted, and, if the earth is anywhere in contact with the corpse, a few pounds of it should be reserved, as it may be expedient to submit it to analysis. If the body has been interred in lead or a close-fitting coffin, and it happens to adhere firmly to its sides, the inspection should, if possible, be made without removing the body.

The viscera and their contents having been carefully removed from the jars that contain them, care being taken to preserve their identity, will have to be submitted to two successive examinations, the one *physical* the other *chemical*.

The *physical examination* will be directed especially to the stomach and intestines, and the matters adhering to their inner surface. Having noted the odour of the contents of the stomach as indicative of the presence of alcohol, phosphorus, hydrocyanic acid, opium and its preparations, sulphuretted hydrogen (as given off from the sulphide of potassium), and a few poisons less commonly employed; and, if in doubt as to the existence of any characteristic odour, warming the organic matters to a temperature not exceeding 100° Fahr.; each part of the intestinal canal should be in turn spread out on a clean sheet of window-glass, with the internal surface outwards. The entire surface should then be searched with the naked eye, the appearances it presents described, and any substances that may happen to attract notice by their form or colour should be particularly examined. This search should then be repeated with a large hand lens, the surface being narrowly scanned by transmitted as well as by reflected light. Such small portions of the organ as present the most marked appearances may then be cut out, spread upon clean glass slides, and examined under the microscope. By this means, in the case of the stomach, we may ascertain the kind of food that has been recently taken, whether it consisted of, or comprised, animal matters revealed by muscular fibres; or adipose tissue, with its polyhedric cells and fat globules wholly soluble in ether; or vegetable matters, with their spiral vessels, stomata of leaves, and chlorophyl soluble in alcohol, and imparting to it its own colour; sometimes also characteristic woody fibre. Or we may find evidence of a particular kind of farinaceous food in the characteristic starch granules of wheat, potato, rice, maize, or Indian corn flour, oatmeal or arrowroot, or the spores of mushrooms.*

Again we may find more or less firmly attached to the mucous membrane certain white powders, as magnesia or its carbonate, or the bicarbonate of soda taken with a meal or after it, or calomel taken as medicine, or arsenious acid given as a poison, and possibly undissolved corrosive sublimate. Imperfectly dissolved crystals, as of oxalic acid, may also be found.

The corrosive action and characteristic discolorations of the mineral acids, and, when the stomach is far advanced in putrefaction, the sulphides of the metals (arsenic yellow, antimony orange, mercury black) or finely divided mercury as a black coating, may also be discovered; as also the green aceto-arsenite of copper, the shining green and gold specks of cantharides, the

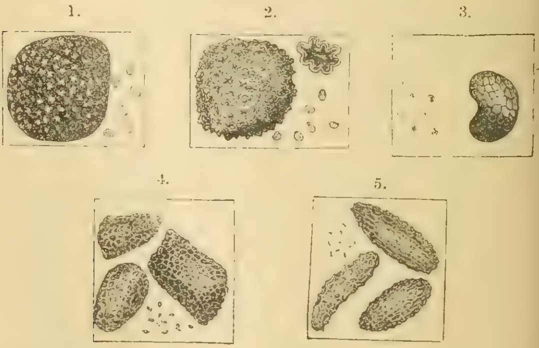
* For the characteristic forms referred to in the text, consult the 'Micrographic Dictionary' of Griffith and Henfrey.

brown powder of nux vomica, the blue of Battle's vermin killer; and, as seen in the dark, the phosphorescent light of phosphorus.

The colour and consistence of the contents of the stomach will afford important indications. The black, dark brown, or greenish brown grumous matter resulting from the action of the mineral acids and oxalic acid on the blood, food, and tissues; and the green matter resulting from the eating of green leaves from the hedges are also characteristic: and sometimes we are assisted by finding fragments of the leaves large enough for identification.

When the fruits of poisonous plants are eaten by children we may find in the stomach or intestines the seeds which they contain. Those of the plants which require the microscope for their identification are shown in the annexed figure, in which—1. Shows the seed of Belladonna; 2. That of Hyoscyamus; 3. That of the Papaver somniferum; 4. That of Digitalis; and 5. That of the Lobelia inflata.

Fig. 39.



Portions of the larger poisonous seeds, such as stramonium, colchicum, aconite, castor, and croton, may also be identified by the colour and markings of their cuticles.

The advantage that may accrue from a thorough examination of the contents of the stomach is well shown by a case given by Tardieu (p. 68). A child twelve years old died at school after ten hours of acute suffering on the day on which its stepmother had brought it several good things to eat. Among the contents of the stomach there were found certain fragments of crumb and crust of bread, which, when examined by the microscope, were

found covered with fungous growth, showing that the bread was mouldy. Arsenious acid was also found in large quantity even in powder. The fact of the mouldy bread was noted down, but no importance seemed to attach to it, till, at the trial, one of the witnesses, a servant of the stepmother, stated that her mistress was in the habit of carrying to the child slices of bread and jam, but that on the day of the death she said that she would not take it, because the bread was mouldy. It had been in that state for one or two days.

Having indicated the precautions to be taken in searching the portions of the alimentary canal reserved with their respective contents for chemical examination, a few hints will now be offered (as reminders to those who possess practical experience, and as necessary instruction to the learner) under the distinct headings suggested by the following considerations.

The poisonous substances submitted to the chemist for examination may be in their pure unmixed form, whether solid or liquid, often in large quantities; or they may be small remnants of powder or crystal adhering to papers from which they were taken, or to cups or glasses out of which they were swallowed. In other instances the poison is dissolved in some common beverage, as beer, brandy, rum, tea, or coffee. In other cases, again, it has to be sought for in the urine; or in the serum as it issues from a blistered surface, or is found in the contents of serous sacs after death; or lastly, the poison may be contained in mixed articles of food of some consistence, spilled in the act of swallowing, voided during life from the stomach and bowels, or found in them after death; or in such thick viscid matters as the blood; or even in the solid structures of the body.

Cases in which the poison exists in a pure state and in large quantity may be disregarded for the present, as belonging rather to the domain of chemistry than to that of toxicology, attention being given to the detection and identification of such minute quantities as those which are extracted from the body itself as ultimate results of long and complicated processes of analysis. The methods of dealing with the minute quantities so obtained are, however, equally applicable to all the more delicate operations of toxicology; so that one division of our subject will be usefully devoted to a description of these methods of procedure. Another division will obviously consist of those methods by which we succeed in reducing thick mixed organic liquids, or the solid textures of the body to a state to pass the filter and become amenable to chemical tests. A third division of the subject should treat of the method of procedure in those rare cases in which an

organic liquid is presented to the chemist for analysis in the belief that it contains some poison, but in ignorance of what that poison is.

The subject of CHEMICAL PROCEDURES will therefore be treated under the following distinct heads:—1. The methods of obtaining a clear liquid from an organic mixture or substance. 2. The method of procedure when the poison contained in an organic mixture or substance is wholly unknown. 3. The methods of detecting and identifying minute quantities of poison.

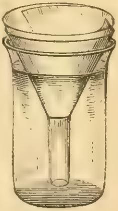
1. There are four methods of obtaining clear solutions—*a.* Simple filtration; *b.* Dialysis; *c.* Filtration following the preliminary coagulation of organic matter; *d.* Filtration following its destruction.

a. Of *filtration*, as commonly practised in the laboratory, it is not necessary to speak; but it may be well to point out that, when we are dealing with small quantities of liquid, we may adopt with advantage a method recommended by Christison. A band of filtering paper is rolled up and bent into the form of a syphon, the short leg of which dips into a watch-glass, or other small vessel containing the poison, and the long leg into a second similar vessel placed beneath it. The paper being moistened with distilled water, will be found to transfer the thinner portion of the mixed liquid from the one vessel to the other.

b. The method of *dialysis* of Graham is founded upon the fact that if a mixed liquid consisting of albuminous, gelatinous, caseous, or gummy matters, on the one hand, and crystalline matters, such as arsenious acid, or strychnia, on the other, be poured into a short cylinder fitted with a suitable membrane after the manner of a tambourine, and then floated on the surface of distilled water, the crystalline matter will pass into the water, and the other matters remain behind. The tambourine-like float is called the *dializer;* the matters which pass through to the distilled water are termed *crystalloids*, and the matters that remain behind *colloids*. The dialyzing membrane recommended for the purpose is the *vegetable parchment* of commerce. This simple and ingenious method, possessed as it is of the obvious advantage that it introduces into the organic liquid no impurity, has not realized the expectations that were formed of it. Tardieu, for instance, says of it that its "results have not been so satisfactory as he had wished;" that crystalline matters, such as arsenious acid and strychnine, pass through only in small quantity, and mixed with a proportion of organic matter; that the method fails with the salts of mercury and copper, and that it is only when the quantity of the poison is very large, not combined with

the tissues, or become insoluble through putrefaction, that the method allows us to isolate a small portion of it; but that even in this case the chemist can arrive at the same result by other means. This statement, justified as it is by experiment,* may be taken as a fair representation of the truth. It limits the use of the method of dialysis to those cases in which we know that we are dealing with considerable quantities of poison, in which dilution with distilled water would not interfere with our future operations, and in which also the loss of several hours of time is unimportant. If, for instance, a chemist receives a matter for analysis in the after part of the day, he may find it advantageous to submit it to dialysis during the night. Assuming then that the method of dialysis will find occasional application, it may be well to indicate one or two simple forms of apparatus suitable for the purpose. For most purposes a common funnel resting on the edge of a tumbler half full of water will suffice. The vegetable parchment, cut and folded as for a common filter, being first soaked in distilled water, is to be applied to the side of the funnel, the matters to be operated on are to be poured into it, and the funnel immersed to nearly the upper edge of the filter. This arrangement is shown in fig. 40. A convenient modification of this arrangement consists of a funnel to the stem of which a glass tube drawn out to a fine point is attached by vulcanized India-rubber controlled by a spring. A filter holds the matter to be dialysed, the funnel itself contains the distilled water, and retains it so long as the spring is in action: when it is loosened the dialysed liquid can be made to fall drop by drop on a glass disk, without waste, evaporated from time to time, and examined by the microscope, and by chemical tests. Or we may apply the method on a smaller scale, substituting a watch-glass for the tumbler, the dialyser folded as a filter, resting on an extemporized support formed out of a square of stout cardboard truncated at the angles, creased near the four corners, and with a circular hole punched out in the centre. The card bent at right angles at the creased lines becomes a convenient support for the filter, which is supposed to dip to the bottom of the watch-glass filled with water. Again, we may operate on a still smaller scale by resting a piece of vegetable parchment the size of a sixpence on a large drop of distilled

Fig. 40.



* Tardieu: 'Sur L'empoisonnement,' p. 100.

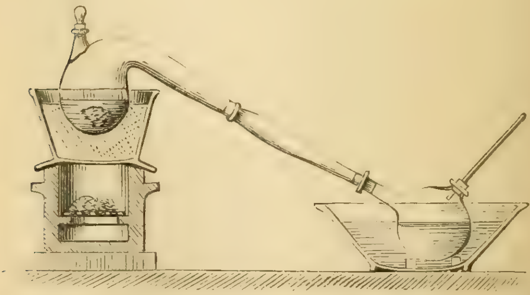
water standing on a disk of glass. The piece of parchment moistened in distilled water, and moulded into a small cup by pressure, contains the speck of matter to be operated on, and its crystalloids pass through to the drop of liquid on the glass disk.

c. Coagulation of organic matter.—This simple method, which also does not introduce any foreign matter into the analysis, might be very largely carried out by heating the organic matters to dryness over a water bath, were it not that some volatile liquid poisons, several of the poisonous alkaloids, and one metallic salt at least, are dissipated by a temperature much below 212°. When, as is the case with most metallic poisons, and some of the most important alkaloids, the subliming temperature exceeds 212°, this simple method may be advantageously adopted. It is also applicable, with like restrictions in respect of poisons which volatilize under 180°, to serous fluids, and to poisons mixed with grease or tallow.

d. Destruction of Organic Matter.—Several methods have been recommended for this purpose, of which two only need be here described—the first as practised chiefly in France, the second in England.

The first method, as recommended and practised by Tardieu and Roussin, was first proposed by Flandin and Danger. The organic matters brought to the consistence of a soft extract (by evaporation over a water-bath if necessary), are heated with a

Fig. 41.



fourth part of their weight of pure concentrated sulphuric acid, in a retort placed over a sand-bath, and attached to a receiver in the manner indicated above. When the acid vapours are no longer given off, the organic matters are found to be reduced to

a dry and friable charcoal, which is to be powdered and treated with strong nitric acid. The acid liquor, which holds the inorganic matters in solution, is to be decanted or filtered, and evaporated to dryness. This dry residue is then dissolved in distilled water. This aqueous solution is free from organic matter, and contains all the metals of which the nitrates are soluble in water, blended, however, with the inorganic constituents of the food and animal fluids and tissues themselves—lime, magnesia, alum, iron, soda, hydrochloric and phosphoric acids.

In the second method, the organic matters, cut into small fragments, or reduced to the consistence of a soft extract, are heated for about an hour in a porcelain dish, over a water-bath, with a mixture of one part hydrochloric acid to six water, and chlorate of potash is then stirred into the mixture by degrees till the solid matters are dissolved and the liquid will pass the filter. It is then filtered, the filter washed several times with distilled water, and the whole liquid, reduced to a convenient bulk, is reserved for examination.

2. Methods of Procedure for Unknown Poisons.—Here again two methods might be described as procedures of the English and French schools respectively—the first as described by Tardieu and Roussin,* the second by Professor Bloxam.† As the method practised by the first-named authorities is not to be found in an English dress, it is given in this place, the reader being referred for English methods of procedure to the works named below.

The first method is applied to a score of the poisons most in use in France, omitting the corrosive mineral acids as sufficiently revealed by their effects. The first step consists in dividing the organic matters supposed to contain poison into two equal parts, of which the one is to serve for the search after inorganic, the other for the search after organic, poisons. These may be conveniently indicated by the letters *A* and *B*.

A. Search for Inorganic Poisons.—The receiver of the apparatus figured on the opposite page is supposed to contain a solution of nitrate of silver. During the first part of the process just described for destroying the organic matters, the vapours that traverse the tube of the retort may be phosphorescent in the dark (*Phosphorus*),

* 'Sur L'empoisonnement,' p. 74 et seq.

† Bowman's 'Medical Chemistry,' edited by Bloxam, p. 284. See also Dr. Odling's 'Course of Practical Chemistry,' for very full instructions applicable to the distinction and identification of poisons. Horsley's 'Toxicologist's Guide' treats the same subject in a very condensed form; and Otto's 'Manual of the Detection of Poisons' may be consulted with advantage.

or, not being phosphorescent, may cause in the silver solution a white precipitate, insoluble in cold, but soluble in hot nitric acid (*Prussic acid*). Neither of these events having occurred, the distillation is carried on till the organic matters are converted into a carbonaceous mass; this is ground to powder in a porcelain mortar, introduced into an open glass vessel with the tenth of its weight of pure nitric acid, boiled for half an hour, diluted with distilled water, and filtered. To the filtrate, ammonia is added till a white precipitate begins to show itself; sulphuretted hydrogen is then transmitted to saturation, the liquid is allowed to stand twenty-four hours, and if a precipitate appears, it is treated according as it is yellow or black; if yellow, and soluble in ammonia, the poison is *arsenic;* if the precipitate is black, it is collected and washed, and boiled for half an hour with pure nitric acid. The greater part of the acid is thus dissipated, and the residue, dissolved in a small quantity of distilled water, is tested as follows:—Dropped on copper foil, it produces a white stain dissipated by heat (*mercury*), or it causes a red stain on an iron plate, which colours ammonia blue (*copper*), or it gives a yellow precipitate with iodide of potassium and a white with sulphate of soda (*lead*). If the sulphuretted hydrogen caused no precipitate, the liquid, evaporated to a tenth of its volume, is introduced into Marsh's apparatus, when, if it yields metallic spots soluble in hypochlorite of soda, it contained *arsenic*. If it yields no metallic spots, recourse is again had to the carbonaceous mass on the filter, which is divided into two parts. The first is boiled for half an hour with a solution of carbonate of soda, and then filtered, the charcoal washed with dilute nitric acid, and the liquids mixed. The acid liquor, evaporated to a convenient quantity, gives with sulphuretted hydrogen a black, and with iodide of potassium a yellow precipitate (*lead*). The second part of the charcoal is boiled with a solution of tartaric acid, and the resulting liquid filtered, and reduced by evaporation. This, tested by Marsh's process, yields metallic stains, soluble in nitric acid, and insoluble in hypochlorite of soda (*antimony*).

B. The apparatus already described (fig. 41, p. 376) is modified thus:—The beak of the retort is introduced into a tube of porcelain, and this latter into a receiver containing a solution of nitrate of silver, and an arrangement is made for passing a current of air through the apparatus. The organic liquid, brought by fine division of the solid matters to the condition of a thin soup, is poured into the retort, which is heated over a sand-bath, and the vapour transmitted through the porcelain tube heated to redness. If the silver solution shows a white precipitate, soluble in

ammonia, and insoluble in boiling nitric acid, the poison was *chloroform*. If no precipitate is formed the contents of the retort are treated by Stas's method, and the resultant of his process, if a strong alkaline liquid, with the odour of tobacco, is *nicotine*: if solid a part of it is introduced into an incision in the thigh of a frog. If it greatly dilates the pupil, and the residue readily dissolves in water, giving a strongly alkaline solution, precipitated brown by iodine, and easily assuming a nauseous odour, it is *atropine*. If the frog is seized with tetanic convulsions, and the residue responds to the well-known colour test, it is *strychnia*. If the frog grows very weak, and has irregular, and intermittent beats of the heart, and if the residue dissolves in warm water, and yields a solution which is not alkaline, but gives a precipitate with tannin, and if the residue itself is coloured green by hydrochloric acid, it is *digitaline*. If the frog presents complex physiological phenomena, and the residue is crystalline, nearly insoluble in water and ether, soluble in caustic potash, and responds to the recognised tests for morphia, it is *opium*.

3. *Detection and Identification of minute quantities of Poison.*—When such minute quantities of poison as the thousandth, ten thousandth, hundred thousandth, or even millionth of a grain are spoken of as easy or possible of detection, inexperienced persons are apt to be incredulous through misapprehension of the bulk of matter which a grain represents.

The best way to correct this misconception is to count the number of distinct visible particles of common objects. I have caused this to be done in the case of certain small seeds, and have found that those of digitalis number 1126 to the grain, and those of lobelia inflata 3176, while the fern seeds of the shops can be counted to the number of 50,900. I have also by successive divisions and subdivisions of a grain of strychnine, the alkaloid being strewn on a surface of black glass, arrived at the $\frac{1}{10000}$th of a grain visible as a bright speck by the naked eye. I have elsewhere shown* that crystals of arsenious acid, weighing as little as the $\frac{1}{250000000}$th of a grain, may be seen and recognised under the microscope. When, therefore, we speak of the ready identification of the thousandth of a grain of arsenic, and the possible recognition of the five thousandth or ten thousandth, we are still speaking of visible particles. When, again, we speak of metallic crusts obtained by Marsh's apparatus, from the half-millionth or millionth of a grain of arsenic, it is only necessary to revert to the fact, that a single grain of gold can be mechanically

* Beale's 'Archives of Medicine,' No. iii. 1858.

divided into 490,000 visible pieces; and into the almost incredible number of 4,900,000,000 fragments visible by the microscope.* Of the recognition of minute quantities of matter by other senses, examples are given in the distinct impression on the sense of smell caused by $\frac{1}{300000}$th of sulphuretted hydrogen, $\frac{1}{40000}$th of bromine, $\frac{1}{1300000}$th of oil of resin, and a still less quantity of musk.

Of the methods of detecting such minute quantities of poison as are here spoken of, some are of partial application (Marsh's apparatus to arsenic and antimony, Reinsch's method chiefly to arsenic, mercury, and antimony, the reduction by zinc mainly to lead, tin, and silver, the blow-pipe and borax bead to metals and their salts), others of most extensive use. Of these the *microscope*, the *method of precipitation*, the *method of sublimation*, the *method of liquid reaction on dry spots*, *crystalline forms*, and the *spectroscope* may be advantageously described and considered. These will accordingly be treated in the order in which they stand.

1. *The Microscope.*—The necessity of resorting to the microscope in cases of rape and wounds, to identify spermatozoa and blood disks, has long been recognised, but it is only very recently that it has come to play a prominent part in toxicology. But already its applications are very extensive, and promise soon to become still more so. One of its recognised uses is to make a preliminary examination of substances supposed to be poisonous, or to contain poison; another to watch the progress and minute characters of those chemical changes which are known as precipitates, as well as to ascertain the crystalline or other forms which they assume when the chemical reaction is complete; a third to note the crystalline and other forms of sublimates obtained by heat, as well as the effect of reagents upon them. By the ingenious adaptations of the spectroscope to the microscope the utility of the instrument is greatly increased and enlarged. As, in future, it is probable that the microscope will be most largely used in examining the forms of crystals obtained by sublimation, by reactions on sublimates, and by drop-precipitation; and especially in watching the whole course of these chemical changes, it is clear that, for medico-legal purposes, the form of microscope to be commended is that which alone enables us to view these phenomena in their entirety—not only to see the dry result of a sublimation or reaction in full relief, but to appreciate fully all the changes that take place on the surface as well as in the

* Miller's 'Elements of Chemistry.'

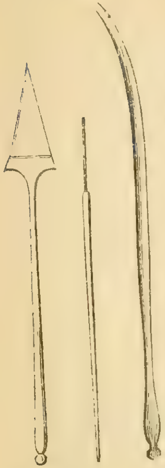
depths of the liquid. All this presupposes the use of a good binocular miscroscope; and as good light and clear definition is in almost every case far more important than mere enlargement, a good inch object-glass, with a deep eye-piece, will be found to meet all the requirements of the great majority of cases; and this we accordingly recommend with the confidence arising out of a very large experience. The combination of an inch object-glass, with a No. 1 eye-piece of our best makers, gives a magnifying power of 50 diameters.

2. *The method of precipitation.*—The method here spoken of is not that which requires the use of the test-tube, but that which is performed under the field of the microscope when a drop of a liquid supposed to contain a poison is treated with another drop of a liquid reagent. It is one which presupposes some delicacy of manipulation and scrupulous cleanliness, and the use of reagents so preserved and applied as to be free from every impurity. This latter desideratum is best accomplished by using a form of bottle which contains a pipette dipping into the liquid itself, and answering the purpose of the glass rod in common use. The annexed figure shows the most convenient form. The pipette, drawn to a fine point at the lower end and sealed at the upper, is ground to fit the neck of the bottle like a stopper. When withdrawn, a drop of the liquid falls from it, and the warmth of the hand expels its contents guttatim. When only small quantities of the reagents are required, the tube may be used both as bottle and pipette. It may be heated in the flame of the spirit-lamp and immersed in the liquid, which will flow into it as the glass cools. In making extempore solutions in a watch-glass, or on a flat surface of glass, as well as in some delicate manipulations, a spatula consisting of a triangular piece of window-glass ground at the edges, thinned at the point, and inserted in a wooden handle, as shown in fig. 43, will be found very serviceable. The smallest fraction of a drop of liquid may be taken up from the drip of the pipette, and the sides may be used to crush small crystals, as well as to draw from the surface of a liquid containing sediment a portion of clear liquid. A piece of platinum wire inserted in a handle, and ground to a point, may be substituted for a steel needle as being more cleanly, and the curved brass forceps may be commended as the best form for these and similar uses. A drop

Fig. 42.

of the liquid supposed to contain poison is to be placed on a glass slide, or the centre of the glass disk presently to be recommended for microscopic sublimates, and carefully examined: the reagent is then to be added without disturbing the slide or disk, and the immediate effect observed, as well as those changes which take place more slowly, and lastly, the liquid having been allowed to dry under a wineglass, is again submitted to examination. The reactions thus produced may take place instantaneously, quickly, or slowly, and they may show themselves on the surface of the glass or liquid, or in the body of the liquid itself. If crystals are formed they may float, lie flat on the glass, or stand up in the fluid as corn on the ground. In the dry spots, also, they may be found on the glass, or projecting from it. It is this variety of place and position that renders the binocular microscope so important, and even essential; for it is no exaggeration to say that a microscopic crystal is not fully seen till it is viewed by this instrument. In using reagents which consist of saline solutions, two most important precautions should never be neglected. The solution should be of a defined strength, and the form of the crystals which it leaves on evaporation should be previously ascertained. These crystals, with very rare exceptions, will be found forming part of the dried spot. For most test-solutions 1 part by weight in 100 is a suitable strength. In some cases, perhaps, it may be well to cover the drop of liquid with a disk of thin glass, and to apply the reagent to the margin.

Fig. 43.



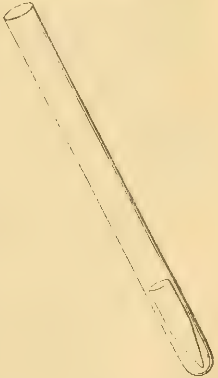
3. *The method of sublimation.*—This method, always largely employed in testing for poisons, has lately acquired a new and increased importance from the interesting discovery of Dr. Helwig, of Mayence,* that the alkaloids when sublimed in the manner which I recommended some years since† for arsenic, corrosive sublimate, and other inorganic poisons, also yield sublimates, some of which are eminently characteristic in their microscopic forms and in their reactions. In attempting to verify the

* 'Das Mikroskop in der Toxikologie,' 1865.
† Beale's 'Archives,' No. iii. 1858.

statements of Helwig, I have seen reason to modify his method, and to extend it to a much larger class of objects.*

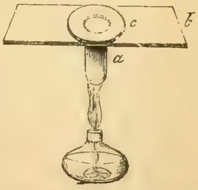
The simplest form of sublimation is with the spirit-lamp and platinum foil. It deals with small quantities of matter, and affords many useful indications. Some poisons, as arsenious acid, corrosive sublimate, oxalic acid, and cantharidine, are sublimed without residue; others, such as the alkaloids, change colour, melt and deposit carbon, and some others undergo no characteristic change. Another method of sublimation commonly practised consists in the use of the spirit-lamp and test-tube, and this, in certain cases, as in those of arsenious acid, corrosive sublimate, and the metals arsenic and mercury, has the twofold advantage of exhibiting the changes caused by heat in the poison itself as well as the character of the sublimate deposited on the higher part of the tube. When this method is practised, great care should be taken to avoid soiling the inside of the tube in introducing the substance under examination. This may be done either by using a smaller tube with funnelled mouth, or by folding a narrow slip of paper lengthways, placing the substance at one end of the groove, introducing the paper carefully into the tube held horizontally, and then raising it with like care. But an easier and simpler plan consists in placing the substance in a short inner tube, and dropping this into the reduction-tube, as in fig. 44.

Fig. 44.



To this method there is the obvious objection that the sublimate, as deposited on the inner surface of a round tube, is not in a favourable state for microscopic examination. This consideration led me to propose the modified plan figured in the annexed engraving. Take a small, clean, dry specimen-tube, *a*, about twice the length and size shown in fig. 45, place it in a hole in a slab of porcelain or brass, *b*, and

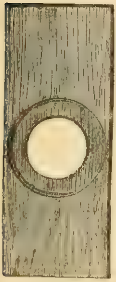
Fig. 45.



* See 'Pharmaceutical Journal,' June to October, 1867; and 'Journal of the Royal Microscopical Society,' January, 1868.

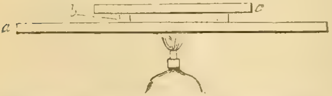
hold it upright. Place the substance to be sublimed at the bottom of the tube. Then hold a disk, *c*, of thin crown glass of the size of a shilling in the flame of the spirit-lamp till it is quite dry: place it over the mouth of the tube, and immediately apply the point of the flame of the lamp steadily to the bottom of the tube, till the lower surface of the glass disk shows a sublimate. Then withdraw the lamp, and repeat the operation with other disks. Place the disks in succession in a wooden holder as in fig. 46,

Fig. 46.



and examine them under the microscope, using reagents if desirable. Another method, to which late discoveries have given great importance, consists in the use of a flat slab of porcelain in lieu of the specimen-tube. A crucible cover supported on a retort-holder answers the purpose well. The substance to be examined is placed on the slab (*a*), fig. 47, in the centre of a ring of glass (*b*), the glass disk (*c*) dried in the flame is made to rest on the ring; the flame of the lamp is then steadily applied to the under surface of the porcelain, and the sublimate is received on the under surface of the disk. The spirit-lamp is then withdrawn, a fresh disk applied, and the operation repeated. When this simple operation is carefully performed, no part of the sublimate escapes. But as it may be well to guard against

Fig. 47.



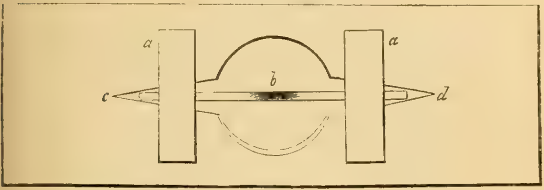
such escape when dealing with very small quantities of matter, and some operators accustomed to the test-tube may prefer some modification of it, the following is suggested:—Draw out a small tube of green glass *a a′* into the form shown in fig. 48; dry the tube by passing it

Fig. 48.

repeatedly through the flame of the spirit-lamp. Introduce the substance to be sublimed into one of the open ends of the tube, as at *b*. Seal the tube at *a*, and shake the slips down to the sealed end. Place the tube in a good side light, and, after heating the capillary portion, apply the flame of the lamp steadily to the end. When the sublimate shows itself, as at *c*, draw off

and seal the capillary tube at *d d* and mount it for the microscope in the manner shown in fig. 49, which represents a card the size of the common slide with a central aperture enlarged by side cuts. The capillary tube *c d*, rests on a perforated label gummed to the back of the card, and is confined to its place by the slips

Fig. 49.

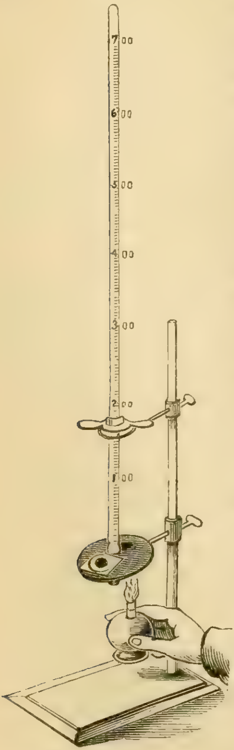


of gummed paper *a a*. Write a memorandum of the date and circumstances of the reduction on the card. As the sides of the capillary tube *c d* are exceedingly thin, they offer no impediment to an examination of the stain *b*, with the higher powers of the microscope. For this form of sublimation a flattened glass tube with long oval section will be found very convenient. But the simple method of procedure described above (fig. 47) is the one which has the greatest value as a means of diagnosis; for it combines the advantage of the platinum foil with that of the reduction tube, inasmuch as the white surface of porcelain seen through the glass disk shows to perfection the direct effect of heat, while the disk carries the sublimate in a form admirably adapted to microscopic examination and the subsequent use of reagents. To show the delicacy of this method, and also that it is not to be objected to as occasioning any loss of material, let it suffice to state that a characteristic sublimate may be obtained from the ten thousandth of a grain of strychnia, and much less than the hundredth of a grain of the *powder* of cantharides.

But it is possible to add greatly to the diagnostic value of this method by a simple arrangement whereby the temperature at which the direct changes of form and colour, and sublimation itself occur may be ascertained. This may be effected by substituting for the porcelain slab a disk of copper with a hollow nipple made to receive a thermometer indicating degrees of heat up to 600° Fahr. or more. The substance to be examined is to be placed on a fragment of microscopic glass, the glass on the copper disk, the glass ring around it, and the disk of glass upon the ring. The flame of the spirit-lamp is then to be steadily

applied to the under-surface of the copper at a point equidistant from the substance itself and the thermometer. This arrangement will be readily understood by reference to the annexed figure.

Fig. 50.



The following are examples of the application of this method as a diagnostic of some of the most active poisons, in such small quantities as the hundredth of a grain or less, supposed to be reduced to powder:—

1. *Corrosive sublimate*, no change of form or colour, sublimes at 200°; will melt at a higher temperature. *Cantharidine*, no change of form or colour, sublimes at 212°; will melt at a higher temperature. *Calomel*, no change of form or colour, sublimes at 240°. *Arsenious acid*, no change of form or colour, sublimes at 280°. The sublimates of corrosive sublimate, cantharidine, and arsenious acid yield crystalline sublimates consisting respectively of groups of needles, groups of plates and prisms, and octahedra. The sublimate from calomel is amorphous.

2. *Tartar emetic* decrepitates at 380°, sublimes slowly and scantily at 480°, and chars at about 550°.

3. *Strychnia.*—No change of form or colour till sublimation at 345°; at 430° melts, darkens, and deposits carbon, still yielding sublimates. *Morphia*, no change of form or colour till 330°, when it sublimes, melts at 340°, darkens and deposits carbon, still yielding sublimates.

4. *Digitaline.*—Darkens, then melts and sublimes at 310°. *Aconitine* melts at 140°, changes colour at 280°, sublimes at 400°. *Atropine* melts at 150°, sublimes at 280°. *Veratrine* melts at 200°, sublimes at 360°, yielding isolated crystals.

Of the method of sublimation conducted in the manner just described, with or without the thermometer, it may be observed

further that it is applicable to the following distinct purposes:—The direct sublimation of white powders or colourless crystals; the sublimation of deposits from solutions; the separation of active volatile poisonous principles from powders which contain them as constituents or admixtures. The following are given as illustrations:—Take a crystalline speck of strychnine. It will yield a distinct white sublimate. Take such a quantity as the $\frac{1}{100}$th grain. It will yield several successive sublimates before and after melting. From the thickest of these proceed to obtain secondary sublimates. Dissolve a grain of arsenious acid in an ounce of distilled water; evaporate a drop on a slab of porcelain and sublime the dry residue. Take the $\frac{1}{100}$th grain of powdered cantharides. It will yield a well-marked sublimate, rendered very distinct if moistened with a drop of ether. Take a drop of the liquid used for browning gun-barrels, which consists of corrosive sublimate, muriate of iron, a salt of copper, and spirits of wine: evaporate it to dryness. It is crystalline, as seen under the microscope. Sublime off the corrosive sublimate, leaving the salts of copper and iron behind. Identify the corrosive sublimate by its crystalline form, and by its reactions with minimum drops of liquor potassæ, and iodide of potassium. Then dissolve the salt of copper with liquor ammoniæ, yielding the characteristic blue solution. Wash with distilled water, and dry; and identify the salt of iron by the Prussian-blue test.

4. *Liquid reactions on dried spots.*—In the course of our toxicological researches we obtain dry spots by sublimation and by deposits from solutions; and these spots often consist of well-defined and highly characteristic crystals. But the crystals may happen to be such as are common to more than one sublimate or deposit, or they may be imperfectly developed or perhaps replaced by amorphous forms. And here liquid reagents may be used with great advantage; and, as the constituents of the dry spot, even when very small in quantity, are in a state of concentration, reagents act upon them in a very satisfactory manner. Thus, in the instances of the sublimates of strychnia, cantharidine, and corrosive sublimate, just cited, the indications afforded by the crystalline forms, if insufficient, are converted into certainty by the addition of the smallest drop of the appropriate reagent, and if proper care be exercised, there is nothing to prevent the application to the same spot of all the reagents which have been found to give characteristic results. For the application of these minute quantities of liquid, a syringe, or a tube covered at one end with india-rubber, and drawn out into a fine point at the other, have been recommended, but they are unnecessary, as the smallest

visible speck of liquid may be readily taken from the drip of a pipette with the fine point of the spatula figured at page 382, (fig. 43.)

5. *Crystalline forms.*—Crystals play so important a part in the detection and identification of minute quantities of poison as to vindicate to themselves a place in this chapter. It has been seen that they are sometimes obtained by sublimation, sometimes by deposit from solution, sometimes by reaction of liquid with liquid, or of liquid with dry spot. Now, in all these cases, without exception, the crystalline forms are subject to modifications for which we ought to be prepared, and with the causes of which we ought, if possible, to make ourselves acquainted. Fortunately, the crystals which most nearly interest the toxicologist are few in number. The most important being the octahedron (the typical form of arsenious acid), the tetrahedron (one of the two forms obtained from solutions of tartar emetic), prisms, six-sided (morphine), four-sided (strychnine and oxalic acid), plates (cantharidine), and needles (corrosive sublimate). As a general rule, it may be stated that the octahedron and tetrahedron are generally isolated and detached, while the rest arrange themselves in groups, presenting the utmost possible variety. But even the detached octahedra are subject to modifications of position and imperfections of structure, which, without some explanation, might lead to difficulties in diagnosis. As the typical crystal of a most important poison (arsenious acid), these modifications and imperfections, with the exceptional forms to be found in almost every group of crystals, may be advantageously considered. The same analysis which presents the varieties of a crystal generally supposed to be peculiarly simple and definite, will serve the further purpose of rendering certain crystalline forms familiar to the student.

The regular octahedron is shown in outline in fig. 51; as it

Fig. 51.

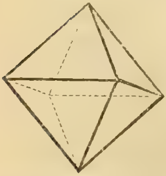


Fig. 52.

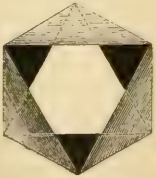
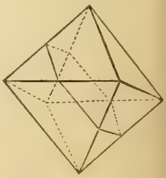


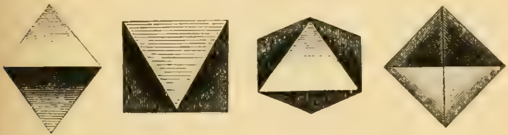
Fig. 53.



appears when a glass model of it is seen with a triangular facette in advance, in fig. 52; and as cleft by a plane parallel to two of

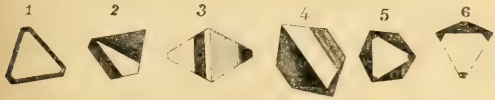
its sides in fig. 53. It consists of eight equilateral triangles joined at their edges; and a section passing through four edges, so as to divide the crystal into two equal parts, shows a perfect square. The section shown in fig. 53 also divides the crystal into two equal parts, each of which has an equilateral triangle for one face and a hexagon for the other. The entire crystal presents itself under different aspects, according as it adheres by an angle, face, or edge, and the light traverses, or is reflected from it. In opaque models, or in groups of crystals seen by reflected light, two, three, or four sides only are displayed as in the annexed illustrations (fig. 54). But when the light is transmitted through the crystals,

Fig. 54.



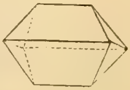
these forms are modified and disguised by such shadows as those shown in fig. 55. It is not often that the eight sides of the octa-

Fig. 55.



hedron are visible, as in the fifth of the series, and in fig. 52, in which the three receding triangles and three dark triangular spots represent six sides, and the two parallel equilateral triangles, the seventh and eighth. Sometimes the octahedron, instead of being moulded on a square, is built on an oblong, assuming the form shown in fig. 56.

Fig. 56.



In most groups of crystals these forms will be recognised; but it should be understood that the octahedron is not always perfect. Its angles may be truncated, sometimes one, sometimes more than one, sometimes all. Its sides may also be indented and its angles rounded, so as to resemble a trefoil (fig. 57).

Fig. 57.

Again, the half crystal formed by the section indicated in fig. 53, like the entire crystal, may present itself in many different attitudes:—1, as a simple equilateral triangle; 2, as an equilateral triangle resting on half the adjoining triangle as a

base; 3, as a simple hexagon; 4, as a hexagon with three small equilateral triangles in shadow; 5, as a truncated equilateral

Fig. 58.

triangle; 6, as a figure having the appearance of a triangular prism (fig. 58).

These half crystals, by the juxtaposition of their corresponding parts, constitute twin-crystals, or *macles*, as in figs. 59 and 60. Rectangular prisms, of which fig. 61, faithfully drawn from a photograph, contains two specimens, are of less frequent occurrence.

Fig. 61.

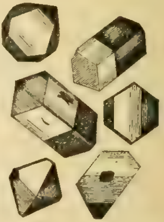
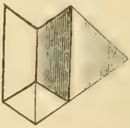


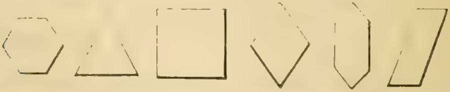
Fig. 59.

Fig. 60.



Plates various in form, size, and thickness are also very common in some specimens (fig. 62).

Fig. 62.



The rhombic dodecahedron, in the various positions shown in the first four of the figures annexed (fig. 63), and the *macles*, or twin

Fig. 63.

crystals, depicted in the fifth and sixth, go far to complete the history of the crystal of arsenious acid taken as an example of a

crystal of definite form, putting on appearances the most various through difference of position, imperfect development, rotation of half crystals, and modifications of form in harmony with the cubical system to which it belongs.*

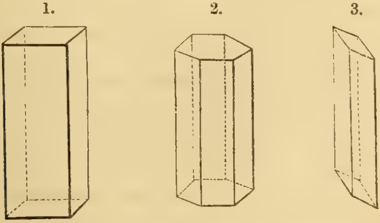
Another crystal which has a certain medico-legal interest, from being present in some deposits from solutions of tartar emetic, is the tetrahedron, shown in outline in (1) fig. 64, together with the alternative form, consisting of a cube with its edges removed, as at 3.

Fig. 64.

The tetrahedron consists of four equilateral triangles, joined at their edges, and presents itself very constantly in the manner shown in the shaded crystal (2, fig. 64).

The remaining crystals with which we have to deal in medico-legal inquiries, are chiefly the prismatic forms and plates which figure so largely among the sublimates and deposits from solutions of the alkaloids. Those most deserving of notice are:

Fig. 65.



1, the rectangular four-sided prism of strychnia; 2, the six-sided prism of morphia; 3, the right rectangular prism of oxalic acid and sulphate of zinc.

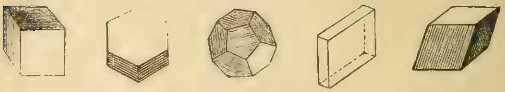
The cubic crystal of iodide of potassium and common salt

* Those who desire fully to understand, or clearly to explain, the crystals of arsenious acid, should study them on the large scale in octahedra of wood and glass, referring to the 'Mineralogy and Crystallography' of Tennant and Mitchell, and using the binocular microscope.

(1, fig. 66), the deep six-sided plates of strychnia, as deposited from solutions in benzole (2), the pentagonal dodecahedron found in the same deposits (3), and the deep square plates of bichromate and ferrocyanate of potash (4), are also worthy of attention. The rhomb (5) is of less medico-legal interest.

Fig. 66.

1. 2. 3. 4. 5.



The crystals obtained by sublimation of the alkaloids, from their solutions in various menstrua, and from their reactions; indeed, crystals from every kind of solution, are subject to great variations in form and grouping.

The causes, of which it is most important to take note, as determining the forms of crystals, are temperature, quantity of material, and strength of solution. Of *temperature*, it will suffice to observe that sometimes, as in the case of sublimates of arsenious acid, it will determine whether a deposit shall be crystalline or amorphous, in others, as in solutions of common salt, whether the crystals shall be cubes or octahedra; of *quantity*, that, in the case of the sublimates of the alkaloids, it has been recognised that the smaller the quantity the more defined the crystals; of *strength of solution*, that this will of itself sometimes determine the form of compound crystals, as in the case of bichromate of potash, which, in strong solution, yields a deposit of deep plates and prisms, in weak solution, of a delicate arborescence. (See Bichromate of Potash.) So important is this cause of variation, that I have thought it expedient throughout this work to indicate the strength of the solution to be tested, as well as of the reagent, adopting for both, as most convenient, the same fraction of one per cent. This precaution is, at least, as necessary as affixing to microscopic objects the scale of enlargement.

6. *Spectrum-analysis.*—This elegant and delicate method of detecting and identifying minute quantities of matter has now been rendered available in medico-legal research, by adapting the necessary apparatus, as an eye-piece, to the monocular microscope. We owe this arrangement to the combined science and skill of Messrs. Sorby and Browning. The eye-piece, which fits into the tube of the microscope, contains within it all the adjustments necessary for placing side by side a spectrum of the object to be examined, and a standard solar spectrum; while a

scale placed beneath the object enables us to measure and describe the place of the absorption-bands which characterize the matter under examination. The most important medico-legal application yet made of this method is to the distinction of the dissolved colouring matter of the blood, whether pure, or acted on by reagents, from colouring matters having the same tint. See p. 313. Of the extreme delicacy of this method there can be no doubt. The detection of one millionth of a grain of the chlorides of strontium and barium, and the twelfth of a millionth of a grain of chloride of lithium, in flame, is confidently asserted to be quite possible. Of the method of analysis generally, it may be here stated that it is one requiring for its successful and safe application practised skill and great care, and that the cases must always be extremely rare in which other more simple and ready methods having failed, we should feel compelled to resort to this.*

To complete the account here given of the methods of analysis applicable to the detection of minute quantities of poison, some notice ought, perhaps, to be taken of the use of *polarized light*, and of the facts relating to *fluorescence*. Of the extreme delicacy of the tests arising out of the application of these phenomena, and of their high value when applied by skilful and practised persons, there can be no doubt; but the descriptions and explanations necessary to enable the student to apply them with safety would occupy more space than is consistent with the plan of this work. For clear explanations of these optical phenomena, the reader is referred to Miller's 'Elements of Chemistry,' Part I.

* The reader is referred to Professor Beale's "How to Work with the Microscope,' 4th edit. p. 218, for a paper by Mr. Sorby himself. Also to 'The Microscope, its History, Construction, and Application,' by Jabez Hogg, sixth edition, p. 119 and p. 735, for a full description of the instrument. See also the 'Proceedings of the Royal Society,' vol. xv. No. 92, for a paper by Mr. Sorby, explaining his scale of measurement; and the 'Pharmaceutical Journal,' Feb. 1862, for a Lecture on Spectrum Analysis, by Prof. W. A. Miller, M.D., V.P.R.S., for a condensed history of the origin and progress of this interesting method of research.

CHAPTER IV.

CORROSIVES.

I. THE MINERAL ACIDS.

SULPHURIC, NITRIC, AND MURIATIC.

II. THE ALKALIES AND THEIR CARBONATES.

POTASH, SODA, AND AMMONIA.

The mineral acids, with the alkalies and their carbonates, make up together a well-defined group of *simple corrosives*—that is to say, of poisons of which the symptoms are due solely to energetic local action. They have no specific remote effects; and in this they differ from the metallic corrosive poisons (the chlorides of mercury, antimony, and zinc, and the nitrates of mercury); from oxalic acid in strong solution; and from phosphorus and iodine in substance.

I. THE MINERAL ACIDS.

In the five years 1852–56, 77 cases of poisoning by these acids were registered, of which 73 were by sulphuric, 2 by nitric, and 2 by muriatic acid.

Poisoning by the mineral acids is not often a homicidal act; but they are sometimes given to adults in place of medicine, or poured down the throat while they are asleep or intoxicated: and more frequently to young children by their mothers or nurses. In infants the act is homicidal, in children either homicidal or accidental, in adults generally suicidal. The mineral acids have also been administered otherwise than by the mouth. One acid (the sulphuric) has been injected into the vagina, another (nitric acid) has been poured into the ear.

These acids are also sometimes used to disfigure the person, or destroy the clothes, or to imitate the destructive action of moths. The sulphuric acid is the one commonly chosen for the work of disfigurement.

The Mineral Acids have the following familiar properties:—they char and destroy organic matters; discolour, and corrode, or injure, the texture of black cloth; redden vegetable blues; and alter or discharge the colour of dyed articles of dress.

The *symptoms* common to these acids are the following:—a sour taste and burning pain in the mouth, throat, and gullet, *immediately* after swallowing the acid; followed by excruciating pain in the stomach, eructations, constant retching, and vomiting of a brownish or blackish matter containing blood, coagulated mucus, flakes of epithelium, or portions of the lining membrane of the gullet and stomach. The act of swallowing is painful, or even impossible, and there is intense thirst. The bowels are costive, the urine scanty or suppressed, and the patient is teased with constant tenesmus and dysuria. The pulse is generally small and frequent, the respiration catching, and sometimes laborious, and the countenance expressive of intense anxiety. In some cases the acid passes into the windpipe, and causes a harassing cough, with croupy respiration and hoarse voice, and the accumulation of tenacious mucus discharged with difficulty, and threatening instant suffocation. The lips are shrivelled, and blistered or excoriated, or they present spots of the characteristic colour of the acid bordered with red; and discoloured spots and streaks running from the angles of the mouth show where the acid has fallen or flowed. The inside of the mouth is white, shrivelled, and corroded, and the teeth loose and discoloured. The tongue is sometimes white and polished, sometimes discoloured. Distinct marks of the acid are also commonly found on the cheeks, neck, or fingers, and on the clothes; and the vomited matters, if rejected on a limestone pavement, cause effervescence. In fatal cases, death is generally preceded by symptoms of collapse, the intellectual faculties remaining clear to the last. Sometimes the patient dies convulsed, sometimes suffocated. Severe nervous symptoms, such as trismus, tetanus, epilepsy, and delirium are occasionally present, and rashes sometimes appear on the skin.

These poisons may destroy life in such small quantities as one or two drachms, and in such short periods as two hours or less. But the fatal event may be postponed for days, weeks, or months. In chronic cases the patient is feverish; has a dry skin and frequent pulse; occasionally vomits his food mixed with flakes of false membrane, or portions of the lining membrane of the gullet and stomach, similar flakes being sometimes discharged from the bowels; and suffers from salivation with fœtor of the breath. The belly is tense; the breathing short and difficult; there are pains and cramps of the limbs; digestion is impaired; all the functions of the body languish; extreme emaciation supervenes; and death happens in a period varying from a fortnight to some months.

Other patients recover imperfectly, to become dyspeptic valetu-

dinarians for life. Rather less than half the number of adults recover completely.

In some instances the poison does not reach the stomach, but affects the throat, gullet, and windpipe. In other cases the acid acts only on the windpipe, causing death by suffocation.

The mineral acids have proved fatal when injected into the bowels or womb, or poured into the ear.

The *post-mortem appearances* common to the mineral acids, are the following:—The lips, chin, and other parts of the body are marked by the acid in the manner just described. The lining membrane of the mouth, tongue, and throat is white, yellow, or brown, shrivelled and corroded; and sometimes coated as with white paint. Portions of the tissues are highly inflamed; sometimes they are gangrenous, sometimes corroded. The epiglottis is sometimes contracted, sometimes swollen, the rima glottidis contracted, and the larynx inflamed. The gullet presents the same appearances as the mouth and throat, and it is common to find its lining membrane more or less extensively detached. (See fig. 69, p. 408.) Sometimes it presents the peculiar wrinkled and worm-eaten appearance shown in fig. 68. In rare cases it becomes the seat of ulceration, and is perforated. Occasionally it entirely escapes. The stomach is usually distended with gas, and filled with a yellow, brown, or black glutinous liquid, which also extends into the gullet and commencement of the small intestines. The lining membrane is highly inflamed, its vessels are minutely injected with black blood; as in fig. 70, p. 408, or black blood is extravasated into its substance; the rugæ are softened, and extensive destruction of its coats, ulceration, and perforation, are of frequent occurrence. The pylorus is commonly contracted. The duodenum presents appearances similar to those found in the stomach. When perforation takes place, the apertures are generally circular, situated at the posterior part of the organ, and surrounded by inflammation and black extravasation. The peritoneal surface of the viscera, even when there is no perforation of the stomach, is highly inflamed and coated with coagulable lymph. When the contents of the stomach escape into the cavity of the abdomen they act upon the viscera, and impart to them a peculiar unctuous feel. The inflammation may extend into the chest, and the thoracic surface of the diaphragm become coated with lymph. The blood in the large vessels is often found firmly coagulated. The urinary bladder is generally empty and contracted.

Exceptions to the general rule of the post-mortem appearances are numerous, partly arising from the strength and quantity of the acid, partly from the full or empty state of the stomach at the

time, and partly from the part of the alimentary canal which the poison reaches. It may not pass beyond the mouth, it may not enter or pass the stomach, or its action may be limited to the upper part of the windpipe.

The *diagnosis* of poisoning by the mineral acids is easy. The sour taste, the *immediate* commencement of the symptoms, the extensive disorganization of all the parts with which the acid comes in contact, the absence of diarrhœa, the stains on the skin, and the injury to the clothes, form a combination not to be attributed to any other cause. In the great majority of cases, both symptoms and post-mortem appearances are decisive of themselves, but when combined they leave no room for doubt. In almost every instance additional evidence is afforded by chemical analysis.

Treatment.—The best antidote would be calcined magnesia, or the carbonate, mixed with water, or with milk and water. But as these are not likely to be at hand, chalk or whiting, the plaster from the ceiling or wall of an apartment, milk, oil, or soap-suds, or soda or potashes, mixed freely with water, should be given without delay. Milk, mucilaginous and oily drinks, and dilute alkaline solutions, should be given freely and frequently for several hours or days.

The corroded and softened state of the parts would forbid the use of the stomach-pump, even if it were possible to introduce it. If the patient is quite unable to swallow, a cautious attempt may be made to introduce the tube into the œsophagus beyond the obstruction. The subsequent treatment must depend on the nature and severity of the symptoms. Leeches to the pit of the stomach are likely to afford relief, and, if grateful to the patient, cold or iced drinks may be prescribed. The bowels must be kept open at first by injections of thin gruel, and as soon as aperients appear safe, by castor oil, previously well-mixed with about twice its quantity of hot milk, and given cold. Excoriations on the surface must be treated as burns.

I. SULPHURIC ACID. (*Oil of Vitriol.*)

In the five years 1852–56, sulphuric acid was credited with 73 out of the 77 deaths attributed to the mineral acids, and it takes the fifth place among the poisons in order of frequency.

The strong acid is sold by druggists and oilmen as "oil of vitriol" to blacking-makers; and the dilute acid as "vitriol," "spirit of vitriol," or "essence of vitriol," for cleaning utensils of copper or brass, at the small charge of 1*d*. for four ounces, or 2*d*. or 3*d*. the pound. In medicine, the strong acid is used in the

cure of ringworm, and the dilute acid is often prescribed as an internal remedy. In the arts the acid is largely used for various purposes, and, among others, for the manufacture of other chemicals; and, as the impure specimens of the acid sometimes contain large quantities of arsenic, that poison is often found in drugs and chemicals as an impurity.

For medico-legal purposes, we have to examine the acid as—1. *The strong acid.* 2. *The dilute acid.* 3. *In stains on cloth.* 4. *In organic mixtures.*

1. *Strong Sulphuric Acid.*

A heavy oily liquid, not fuming, colourless when pure, but, as found in commerce, of a light brown tint. It chars organic matter, and, when added to water, gives out heat. When heated with copper turnings, sulphurous acid is given off, which liberates iodine from iodic acid. It developes colours with several of the alkaloids, with or without the aid of heat. With veratrine it turns first yellow, then, after a time, crimson, which colour is immediately produced by warming the acid. This is a characteristic reaction of the free acid. With meconine it strikes when warmed a clear blue.

2. *Dilute Sulphuric Acid.*

A colourless liquid, of a strong acid taste, which reddens litmus, and chars paper when dried,* and gives with a solution of nitrate of barium a white precipitate, insoluble in nitric acid; which precipitate being collected, washed, and dried, mixed with black flux, and heated on charcoal in the reducing flame of the blowpipe, is converted into the sulphide; and this, moistened with dilute hydrochloric acid, gives off sulphuretted hydrogen. By this three-fold process an acid liquid is proved to contain sulphuric acid; but not necessarily as free acid. It may be a constituent of a supersulphate, such as alum; or of a neutral sulphate, such as Epsom salts, with some other free acid in excess. The presence of a saline ingredient may be verified by evaporating the acid liquid; and the volatile acids, such as the acetic and hydrochloric, may be separated by distillation, and identified by appropriate tests. Wormley recommends veratrine as the

* This charring property is so remarkable as to constitute a test. If a strip of filtering paper be dipped in a liquid containing a single minim of the strong acid to 800 of water, and then dried before a fire without scorching the paper, the part touched by the acid becomes black and brittle. Hydrochloric acid has the same property, though in a lower degree.

best test for the free acid, and one in every respect superior to Runge's cane-sugar test. If a fragment of the alkaloid be dropped into a liquid containing as little as the one-thousandth of a grain of the free acid, and dissolved by the aid of heat, it forms a colourless mixture, which, evaporated to dryness, leaves a deposit with a fine crimson border.

3. *Stains on Cloth.*

The strong acid stains black cloth, first red, then brown, and corrodes it. The stain continues moist for months or years, and will yield an acid reaction. The dilute acid produces the same change of colour, and corrodes in a less degree; but the spots are dry.

To detect the acid, the stained fragment of cloth must be boiled in a small quantity of distilled water. The liquid must then be filtered, and tested for free sulphuric acid. A drop of the filtrate should be evaporated on a glass slide, and if a visible stain remains, it should be examined for saline matters, and an unstained portion of the same cloth should be examined in the same way.

Clean linen and cotton fabrics corroded by the acid may be submitted to destructive distillation in a reduction-tube, in the mouth of which a slip of filtering paper, moistened with solution of starch, and sprinkled with iodic acid, is placed. The released iodine reveals its presence by the blue iodide of farina. This process is not applicable to woollen textures, which contain sulphates, to the coats of the stomach, or to its contents. A parallel experiment should always be made with an unstained portion of the same material.

4. *Organic Mixtures.*

Liquids containing organic matter, such as tea and coffee, beer and porter, if thick or turbid, must be boiled with distilled water, and filtered through paper supported by muslin; if clear, they may be filtered at once. The coloured precipitate thrown down by nitric acid and nitrate of baryta is to be collected, boiled in strong nitric acid, to destroy the organic matter, and converted into sulphide of barium, as above.

The contents of the stomach, or the matters rejected by vomiting, will have a strong acid reaction if no antidote has been given; but if the case has received medical treatment, or the patient has survived some time, they may be neutral, or even alkaline.

a. If they have an acid reaction, it is probable that they contain a free acid, which may be sulphuric acid, or one of the two acids usually found in the stomach, the acetic and hydrochloric. These acids may be separated by distilling the filtered liquid (see Hydrochloric Acid), till it attains the consistence of a thin syrup. If the tests for hydrochloric and acetic acids give a negative result, the liquid in the retort must be diluted, filtered, and tested for sulphuric acid. If, however, the product of distillation contain either acid, we dilute the liquid in the retort, and continue the distillation, adding fresh water if necessary, till all trace of these acids disappears. The fluid remaining in the retort is then to be tested for sulphuric acid.

If the fluid has an acid reaction, and also leaves a saline deposit on evaporation; and the result of distillation proves that the free acid is the sulphuric, we are dealing either with a supersulphate, such as alum, or with a sulphate, such as Epsom salts, combined with free sulphuric acid. In the latter case, we ascertain the quantity of the uncombined acid, by adding carbonate of baryta till effervescence ceases. The quantity of free acid may be calculated from the weight of the resulting sulphate of baryta.

b. If the organic matters have an alkaline reaction, or are neutral, they must be boiled in distilled water, and filtered; the tests being applied to the filtered liquid.

If carbonate of lime has been given as an antidote, the resulting sulphate of lime must be dissolved by boiling with nitric acid.

If the quantity of acid discovered by any of these processes is very small, there is no proof that it has been swallowed; for the secretions of the stomach always contain a small quantity of neutral sulphates. Nor does the discovery of a neutral sulphate, such as the sulphate of magnesia, prove the administration of free sulphuric acid, for the salt itself may have been given as an aperient. The discovery of sulphate of lime, however, by proving the administration of sulphuric acid, and the subsequent use of chalk as an antidote, would be as conclusive as the finding of the free acid.

But where the characteristic appearances of poisoning with sulphuric acid are present, chemical analysis becomes superfluous. It can be required only in those rare cases in which the acid taken was so dilute as not to occasion any characteristic post-mortem appearances.

Sulphuric acid has been detected in the blood and also in parts of the body to which it must have been conveyed by the circula-

tion—in the peritoneum, pleura, heart, and bladder, and even in the liquor amnii, and body of the fœtus. The milk of nurses taking the acid has produced disordered bowels and convulsions in the infants suckled; and in one case* the matters voided from the bowels were found to corrode the napkin.

Quantitative Analysis.—Use for this purpose the precipitated sulphate of baryta, boiled in pure nitric acid, washed and dried. In 100 grains of the sulphate there are $41\frac{1}{2}$ grains of the strong acid.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those already described at p. 395, but severe in proportion to the strength and corrosive properties of the acid. Severe nervous symptoms are sometimes present, such as locked-jaw, rigid spasms of the extremities, epilepsy, and delirium.

Diagnosis.—The dark-brown stains on the skin, and the moist brown corroded stains on black cloth, are characteristic of this acid.

Post-mortem appearances.—Those described at p. 396; but the disorganization greater, and perforation more frequent (about a third of the cases), than in poisoning by the other mineral acids. The colour of the epithelium and mucous membrane dark-brown or black, as if charred; while in cases of poisoning by nitric acid it is more commonly yellow or green. When thickly coated with mucus, the lining membrane of the mouth and alimentary canal appears as if smeared with white paint. This is the effect of the acid on the secretions of the alimentary canal after death (Dr. Chowne). The post-mortem effect on the mucous membrane itself is to render it yellowish and brittle, to bleach the muscular and peritoneal coat, and to char the blood in the vessels (Orfila).

Fatal dose.—In the adult, one drachm: in an infant five weeks old, half a drachm. Four ounces has been swallowed by an adult without fatal consequences.

Fatal period.—*Shortest* one hour: in a child "*almost immediately.*" Life may be prolonged for several days, weeks, or months, up to the limit of two years. *Average.*—In cases that prove fatal within 24 hours, about 10 hours.

Mortality.—Almost all infants and young children. In adults, two-thirds of the cases.†

Treatment.—That already described at p. 397.

* 'Medical Gazette,' vol. i. pp. 710 and 756.

† The following are the results of several cases reported in the English and Foreign Journals:—

Sulphuric acid has been injected into the vagina as an abortive; and into the rectum by mistake for a clyster; and it is used to disfigure the face and injure the dress. The local treatment of parts thus injured consists in the use of a solution of carbonate of potash or soda till effervescence ceases, followed by that appropriate to burns.

II. NITRIC ACID (*Aqua Fortis, Red Spirit of Nitre*).

This acid is much less in use as a poison than sulphuric acid, but much more than hydrochloric acid. It caused two deaths only in the five years 1852–56.

The poison may present itself for analysis, as—1. *The strong acid.* 2. *The dilute acid.* 3. *In stains on cloth.* 4. *In organic mixtures.*

1. *Strong Nitric Acid.*

The commercial acid varies in colour from a deep orange to a light yellow; gives out orange-coloured acid fumes; produces dry yellow stains in woollen tissues, and corrodes them, and causes similar stains in other articles of dress and in the nails, skin, and other tissues of the body. These stains assume a bright orange tint when touched with an alkali. Dissolves copper with brisk effervescence and escape of ruddy acid fumes, a greenish liquid remaining. With morphia and its salts, the acid strikes a rich orange colour, effervesces, and gives off orange fumes; and with brucia a blood-red.

Of 36 cases (the majority females)—26 were fatal (all the children and 18 adults), and 10 recovered (all adults).

Of 31 cases—20 were suicidal, 3 homicidal (all young children), and 8 accidental (2 of them children).

Among adults, both in accidental and suicidal poisoning, there was 1 recovery to 2 deaths.

Of the 26 fatal cases, 10 lasted a day or less; 6 more than a day and less than a week; 3 less than a fortnight; 1 from a fortnight to three weeks; 1 more than three weeks; and 5 extended from five to forty-five weeks.

The *least* duration in 5 children was three and a half hours, the *greatest* three days. In 20 adults the *least* was also three and a half hours, the greatest forty-five weeks.

The *average* in all surviving a day or less was ten hours—of all surviving a week or less thirty-two hours.

The recoveries are stated to have taken place in from 6 to 23 days.

Perforation of the stomach took place in 8 cases out of 21 in which the post-mortem appearances are described.

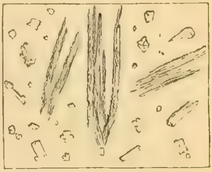
Cases reported in English Journals, or extracted from foreign publications:—

'Ed. Med. and Surg. Journal,' vols. x., xxii., xxvi., xxxvi., and vol. liii. p. 406 et seq. (an interesting case by Dr. Craigie, with many valuable cases from foreign sources).—'Lancet,' 1834–5, i. p. 266; 1836–7, i. p. 195; 1837–8, ii. p. 782.—'Medical Gazette,' vol. i. p. 127; vol. vii. p. 27; vol. xxii. p. 76; vol. xxv. p. 944; vol. xxix. p. 147; vol. xxx. p. 352.—'Medical and Physical Journal,' vol. i. p. 500.—'Medical Repository,' vol. xiv. p. 160.—'Guy's Hospital Reports,' vol. iv. p. 297.—See also Roupell's 'Illustrations of the Effects of Poisons.'

2. *Dilute Nitric Acid.*

A volatile acid liquid, which reddens litmus, and is not precipitated by nitrate of baryta or nitrate of silver. From the absence of precipitate with these reagents it may be inferred that the acid is neither sulphuric nor hydrochloric, nor any of the common vegetable acids. This presumption is converted into certainty by the following tests:—*a.* When boiled with copper filings, provided the acid be not very dilute, the characteristic orange fumes are given off. *b.* If carbonate of potash is added to the liquid till effervescence ceases, and a piece of filtering paper is dipped into the liquid and dried, it burns like touch-paper. *c.* On slowly evaporating the liquid, it yields crystals of nitrate of potash, of the form annexed.

Fig. 67.



Solution 1 in 100.

The crystals of nitrate of potash obtained in this manner from the solution, yield further corroborative proofs of the nature of the acid, by the following reactions:—*a.* When ignited on charcoal, they burn with deflagration. *b.* On adding strong sulphuric acid, a colourless vapour with the peculiar odour of nitric acid is given off. *c.* Drop a fragment of the salt into a small test-tube, add a few drops of distilled water, and then a drop of strong sulphuric acid; drop in a fragment of copper: the characteristic ruddy fumes will be given off. *d.* Proceed as in *c*, and add one or two drops of strong hydrochloric acid: the resulting liquid dissolves gold leaf. The following tests are best applied on a slab of white porcelain:—*e.* Moisten a crystal of the salt with distilled water, add a drop of pure concentrated sulphuric acid, and dissolve by the heat of a spirit-lamp, allow the liquid to cool, and introduce into it a fragment of the green sulphate of iron; a dark green ring, changing to brown, will form round the crystal. *f.* Proceed as in *e*, and substitute a fragment of morphia. It strikes a rich orange colour, and produces a yellow liquid. *g.* Proceed as in *e*, and substitute a fragment of brucia. It strikes a blood red. *h.* Proceed as in *e*, and add a fragment of narcotine. A reddish-brown colour is produced, changing with a gentle heat to deep blood-red. The following may be added as an excellent test for any nitrate. Place in a test-tube a few drops of sulphuric acid, and add a small quantity of distilled water: add a fragment of pyrogallic acid. Then allow a few drops of strong sulphuric acid to trickle down the side of the tube and subside to the

bottom. Add a few crystals of common salt, and when the effervescence ceases, drop in the crystal of the nitrate. The acid at the bottom of the tube puts on an intense purple hue, which may extend to the rest of the liquid. (Horsley, confirmed by Wormley.)

3. *Stains on Cloth.*

Boil the fragment of cloth in a small quantity of distilled water. The presence of an acid will be indicated by test-paper; and that of nitric acid by the appearance of the stain. Neutralize with carbonate of potash, and filter. The dry filter burns like touch-paper. Evaporate the liquid, collect and examine the crystals by the microscope, and apply the brucia test as above; and if possible the other tests in succession.

To distinguish stains of nitric acid from those caused by iodine or by bile, test with a weak solution of caustic potash. The indelible nitric acid stain assumes a clear orange tint. That caused by iodine immediately disappears; the bile-stain undergoes no change.

4. *Organic Mixtures.*

If the liquid is viscid, dilute with distilled water, boil, and filter. If it has an acid reaction, neutralize with carbonate of potash, crystallize, and apply the tests just described.

If antidotes, such as chalk or magnesia, have been given, the liquid, instead of having an acid reaction, may be neutral or feebly alkaline. In this case, also, the filtered liquid is to be neutralized with carbonate of potash; soluble nitrate of potash will be formed, and insoluble carbonate of lime or magnesia thrown down, and separated by fresh filtration. The filtered liquid is then to be evaporated, and the crystalline residue tested for nitrate of potash.

When the quantity of acid in the organic liquid is very small, it may be removed from the vessel containing it by means of a rough syphon formed of filtering paper. (Christison.)

Mucous membrane acted on by the acid may be treated as fragments of cloth.

In the case of nitric as of sulphuric acid, the post-mortem appearances are so characteristic as to render chemical analysis unnecessary.

Quantitative analysis.—To the nitrate of potash add strong sulphuric acid; dissolve the sulphate, calcine it, wash with alcohol to remove free acid, and evaporate to dryness. For one hundred grains of the dry sulphate allow about eighty-two grains of the strong acid.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those already described (p. 395). A miliary rash, with intolerable itching, was present in one case on the sixth day.

Diagnosis.—The yellow stains on the skin, and the dry yellow corrosions on the dress, are characteristic of this acid. The discovery of these stains on the person and dress of an accused person has led to his conviction.

Post-mortem appearances.—Those already described (p. 396). The colour of the mucous membrane yellow, or green in parts of the stomach and intestines containing bile. The degree of corrosion less, and perforation more rare, than in the case of sulphuric acid.

Fatal dose.—Two drachms. (Taylor.) In infants less. Recovery has taken place after half an ounce, or more.

Fatal period (*shortest*).—In the adult an hour and three quarters: in the infant a few minutes.

Average.—In the majority of fatal cases death takes place within twenty-four hours; but life may be prolonged to several days, weeks, or months.

Mortality.—About half the cases.

Treatment.—As for the mineral acids generally (p. 397).

Nitric acid has been poured into the ear, and caused sloughing, abundant hæmorrhage, paralysis jactitans, extreme debility, and death in about thirteen weeks.*

The orange fumes given off when nitric acid is poured upon copper or mercury (and commonly known as nitrous acid gas) are produced in large quantity in some processes of the arts, such as water-gilding and brass-button making. They irritate the eyes and lungs, and give rise to a troublesome cough, renewed by each repetition of the process; and at length becoming habitual. In more than one instance it has proved fatal in periods varying from twenty-seven hours to two days. The *symptoms* are burning heat in the throat; tightness at the chest and pit of the stomach; extreme distension and acute pain of the abdomen; nausea and vomiting; purging of a yellow matter; scanty secretion of urine and dysuria; cough, at first dry, then attended by scanty orange expectoration, with extreme dyspnœa, and feeling of impending suffocation; transient delirium; extreme debility; inexpressible anxiety; and death after convulsions. The *post-mortem appearances* consist in signs of acute inflammation and its consequences in the air-passages and lungs, and in the alimentary canal, engorgement of the lungs and heart with black liquid blood, distension of the stomach and intestines with gas, and a yellow colour of the

* 'Medical Gazette,' March, 1830.

contents of the air-passages and alimentary canal. Manufacturers who produce these irritating fumes should be required to conduct them into the nearest chimney.

The binoxide or deutoxide of nitrogen gives rise to these orange fumes by combining with air in the lungs. Accordingly Sir H. Davy suffered very severely when he tried to inhale the binoxide.

III. MURIATIC ACID (*Hydrochloric Acid, Spirit of Salt*).

Though muriatic acid is somewhat largely employed in the arts, it is not often used as a poison, No case of poisoning by it was reported in the years 1837-38; only two cases in the five years 1852-56; and less than half a dozen cases have occurred since that time. The poison may have to be examined—1. *As the strong acid.* 2. *The diluted acid.* 3. *In stains on cloth.* 4. *In organic mixtures.*

1. *Strong Muriatic Acid.*

The acid of commerce is of a yellow colour, fuming in moist air, and yielding dense white vapours with ammonia. It produces a dry green stain on black cloth, but does not corrode it; or the stain is first red and then green. It is distinguished from sulphuric acid by its colour, and from nitric acid by the absence of orange fumes when poured on copper. When boiled with peroxide of manganese, chlorine is given off, which is known by its colour, odour, and bleaching properties.

2. *Dilute Muriatic Acid.*

The liquid is proved to contain an acid by the use of litmus paper. The nitric acid and nitrate of baryta test causes no precipitate. It is probable, therefore, that the acid is either nitric or muriatic. If a solution of nitrate of silver yields a dense white precipitate insoluble in nitric acid, and in caustic potash, but very soluble in ammonia, and which, when dried and heated, fuses into a yellow liquid, which on cooling becomes a soft horny mass, the acid is certainly muriatic.

As a chloride (such as common salt) with a free acid would have an acid reaction, and yield the same white precipitate with nitrate of silver, a drop of the liquid should be evaporated, when, if there is a crystalline residue, the acid should be distilled over and the crystalline residue examined by the microscope, and tested.

3. *Stains on Cloth.*

Boil the stained cloth in distilled water, filter, test with nitrate

of silver, and identify the precipitate as above. Examine, at the same time, an unstained portion of the same cloth.

4. *Organic Mixtures.*

Most organic liquids contain muriatic acid free or combined, and most organic matters yield a precipitate with nitrate of silver. In the contents of the stomach, the acid may either exist in the free state, in which case the liquid will have a strong acid reaction, or it may be combined with an antidote, in which case the liquid may be neutral.

If the liquid has a strong *acid* reaction, we submit it to distillation at a low temperature, by immersing the retort in a boiling solution of chloride of calcium (two parts of the salt to one of water), the distillation being repeated by adding distilled water to the dry residue. The liquid in the receiver may be treated as pure dilute acid.

The detection of free muriatic acid in the contents of the stomach only in minute quantity does not prove its exhibition as a poison, for the gastric juice itself contains a minute proportion (one part in 1500) of free muriatic acid. But when the acid is found in appreciable quantity in the stomach of one in whom the symptoms and the post-mortem appearances were such as a mineral acid would produce, the cause of death admits of no doubt.

If the organic liquid is neutral, it may either contain no muriatic acid, or the acid may be combined with an antidote—magnesia, lime, soda, or potash. In this case we evaporate to dryness and calcine, dissolve the residue, and test the solution with nitrate of silver.

If the residue consist of common salt, it may have resulted from the administration of carbonate of soda as an antidote, or it may have formed part of the food. In this case also the chemical analysis must be confirmed by the symptoms and post-mortem appearances, and the stains which we may discover on the clothes.

Quantitative Analysis.—Use for this purpose the dried precipitated chloride of silver, of which 100 grains are equivalent to 69 grains of liquid muriatic acid.

Symptoms.—Those already described (p. 395).

Post-mortem Appearances.—Those already described (p. 396). In a suicidal case, in which a large quantity of the strong acid proved fatal in less than twenty-four hours, the epithelium of the throat and gullet was destroyed in patches, and the stomach contained a large quantity of black grumous matter, adhering to the surface so as to admit of being preserved. The preparation (presented by Mr. Bowman), with a drawing of the recent gullet

and stomach, is in the Museum at King's College. As the appearances in this case, especially the shrivelled and worm-eaten aspect of the gullet, bear a very near resemblance to those present in cases of poisoning by sulphuric acid (see Roupell's Plates) and to one case of poisoning by oxalic acid which came under my notice, I append three woodcuts, which, even in the absence of colours, convey a very clear idea of the actual appearances. Fig. 68 shows the corrugated and worm-eaten appearance

Fig. 68.

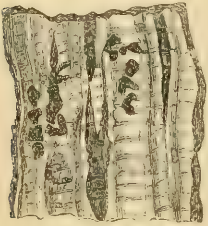


Fig. 69.

of the gullet; fig. 69 a portion of the gullet from which a large patch of epithelium has been removed, and fig. 70 the appearance of the stomach with its black grumous contents and vessels injected with black blood.

Fig. 70.

In order that undue importance, as a sign of corrosive poisoning, may not attach to the injection of the vessels of the stomach with black blood, or to the removal of portions of the lining membrane, I append a well-executed engraving (fig. 71), about one-fourth the natural size, of the stomach of a female prisoner who died from pulmonary consumption. It is taken from a drawing by Dr. Westmacott, made while the stomach was fresh. The black granular appearance of portions of the stomach, the fine black injection of the vessels, the deep red vertical streaks and irregular spots, with the three abraded patches, are remarkable illustrations of the effects of acid secretions of the stomach before and after death. The absence of such appearances in the gullet as are shown above, and of the grumous matters just described, to say nothing of a like absence of characteristic marks on the lips, mouth, and tongue, on the external surface of the body, and on the clothes, would prevent us from attributing such

appearances to poisoning. In the very rare cases in which the corrosive acid, being rapidly swallowed, affects the stomach only,

Fig. 71.

we should expect more marked appearances of corrosion in that organ, together with characteristic grumous matter.

The lining membrane of the stomach and intestines sometimes has a yellow tint, or it is green from the action of the acid on the bile. No case of perforation has yet been reported; but in a case of poisioning by a large dose of the dilute acid reported by Puchelt of Heidelberg, the entire stomach is stated to have been destroyed, and rejected by vomiting.

Fatal dose.—Half an ounce.

Shortest fatal period.—Five hours and a half.

Average period.—About twenty-four hours.

Treatment.—That of poisoning by the other mineral acids (p. 397).

Nitric acid mixed with sulphuric, under the name of *aqua reginæ*, and with muriatic acid, under the title of *aqua regia*, are used in the arts, the one to separate silver from plated articles and in the manufacture of collodion, the other to dissolve gold and platinum.

The mineral acids have also been taken in a state of mixture with other substances—nitric acid with laudanum, aloes, &c.; and muriatic acid, in combination with tincture of iron and corrosive sublimate, is in common use for browning gun-barrels, and has been taken as a poison in one case.*

* 'Medical Gazette,' Nov. 1839.

II. THE ALKALIES AND THEIR CARBONATES.

The alkalies and their carbonates share with the preceding group of irritants, the mineral acids, the property of destroying the animal tissues by the violence of their action, at the same time that they give rise to no specific remote effects. But they act as corrosives only when swallowed in substance, or in strong solution, resembling in this respect the concentrated acids or their less dilute mixtures.

The alkalies and their carbonates, in common with the alkaline earths, are distinguished from one class of the metals by the negative effect of sulphide of ammonium, from another class by the negative effect of hydrosulphuric acid and sulphide of ammonium. They resemble the alkaline earths in having an alkaline reaction; but they differ from them in yielding no precipitate with carbonate of ammonia.

Though they are in common use for household purposes, or as medicines, they are very seldom taken as poisons.

I. POTASH AND CARBONATE OF POTASH.

Caustic Potash, as used in the laboratory, is in the form of greyish masses, presenting an imperfect crystalline texture. It is soapy to the touch, acrid to the taste, highly deliquescent, fusible by heat, rapidly absorbs carbonic acid from the air, and is very soluble in water. When fused in small cylindrical moulds it is the *potassa fusa* of the shops.

In solution as *liquor potassæ* it has a strong alkaline reaction; changes the colour of black cloth to brown; is not precipitated by carbonic or sulphuric acid, but yields with a solution of bichloride of platinum a yellow precipitate.

The *carbonate of potash, bicarbonate of potash*, or *salt of tartar*, is sold by oilmen in two forms. 1. As a mottled deliquescent mass—grey, yellow, brown, and black—with a soapy feel, urinous taste, and strong alkaline reaction. In this form it is known as *Potash* or *Potashes*, and is used chiefly for cleaning oil lamps. 2. In small white grains, or as a white semi-crystalline mass, having similar detergent properties, and used for washing and other cleansing purposes. In this form it is known as *Pearlash*.

We may have to examine and identify these salts—1. *In substance.* 2. *In solution.* 3. *In organic mixtures.*

1. *In Substance.*

Potash (or potashes) is readily recognised by the physical properties just described. The more pure form of carbonate of potash requires to be distinguished from carbonate of soda, and from other white powders. It has an alkaline reaction, effervesces and gives out carbonic acid when treated by acids, and imparts a violet tint to the deoxidizing flame of the blowpipe. It is very soluble, and has in a state of solution the properties now to be described.

2. *In Solution.*

A solution of carbonate of potash when evaporated on platinum foil leaves a white deposit not dissipated by heat, and is thus distinguished from the salts of ammonia: it has an alkaline reaction; it yields a yellow precipitate with a solution of bichloride of platinum, in which respect it resembles the salts of ammonia, but differs from those of soda; it gives a colourless precipitate of bitartrate of potash with a solution of tartaric acid, which precipitate is promoted by agitation and by friction with a glass rod.

3. *In Organic Mixtures.*

If an organic liquid has a strong alkaline reaction, there is a presumption in favour of one of the substances contained in this chapter. By diluting and filtering the liquid, and applying trial tests, it will be easy to ascertain which of the three alkalies is present. The process for the carbonate of potash consists in evaporating the organic matter to dryness, incinerating the residue, treating the ash with distilled water, and applying to the solution the tests just enumerated.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—When a strong solution of the poison is taken, an acrid burning taste is perceived in the act of swallowing, followed immediately by a burning sensation in the throat and gullet; and this after a short interval by acute pain in the pit of the stomach, with great tenderness on pressure; and frequent vomiting of a tenacious bloody mucus, of a brown grumous matter, or of flakes of epithelium. Violent colic pains, with tension and tenderness of the abdomen, soon supervene, with purging of stringy mucus mixed with blood. There is much difficulty in swallowing, and sometimes hoarseness of the voice, and cough. In fatal cases, death takes place from collapse, or after prolonged sufferings from increasing difficulty in swallowing, constant vomiting of

blood, bloody stools, and tenesmus. In chronic cases the patient dies from starvation, brought on by stricture of the œsophagus.

Post-mortem appearances.—The lining membrane of the throat and gullet is softened and corroded; the œsophagus, stomach, and intestines are inflamed, with abrasion and ulceration of the lining membrane, and dark spots or patches caused by extravasated blood. Sometimes the inflammation extends to the larynx. In chronic cases, large portions of epithelium and mucous membrane are found removed, and the gullet and stomach are contracted. Perforation has not taken place in any of the recorded cases.

Fatal quantity.—Half an ounce.

Fatal period.—*Shortest,* three hours. *Average,* in the majority of cases, within twenty-four hours. In chronic cases, the fatal event may be delayed for days, weeks, months, or even years.

Treatment.—As an antidote, vinegar largely diluted with water, or lemon-juice and water. Acidulated demulcent drinks, and the juice of oranges and ripe fruits may then be freely administered, and almond or olive oil. Inflammatory symptoms must be combated with antiphlogistics, pain by preparations of opium, and collapse, if present, by stimulants. The stomach-pump should not be used.

II. SODA AND CARBONATE OF SODA.

Caustic soda has no medico-legal interest. *Carbonate of soda* is sold by oilmen for cleansing purposes, in two forms, as *soda* and *best soda*—the soda in a dirty crystalline mass, the best soda in masses of a purer white. In common with potash, carbonate of soda may have to be identified in substance, in solution, and in organic mixtures.

1. *In Substance.*

Carbonate of soda has an alkaline reaction; it effervesces and gives out carbonic acid when treated with an acid; it readily crystallizes, and is effervescent, and it imparts a yellow colour to the flame of the blowpipe.

2. *In Solution.*

A solution of carbonate of soda differs from a solution of carbonate of potash by yielding no precipitate with the bichloride of platinum, or with tartaric acid; while it gives with antimoniate of potash a white crystalline precipitate. Further distinctions might, if necessary, be founded on the form and character of the salts of the two alkalies. When converted into nitrates by dilute nitric acid, soda crystallizes as rhombic plates, and potash as prisms.

3. *In Organic Mixtures.*

The process for organic liquids is the same as for carbonate of potash.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those of poisoning by carbonate of potash, but of less severity.

Post-mortem Appearances.—Those of poisoning by carbonate of potash, but less marked.

Treatment.—That of poisoning by carbonate of potash.

III. AMMONIA AND CARBONATE OF AMMONIA.

Ammonia in the form of gas, or dissolved in water, as the *liquor ammoniæ*, or combined with carbonic acid as the *sesquicarbonate*, is largely used in medicine and the arts, and occasionally taken as a poison, generally by accident, rarely with intent to destroy life. The incautious use of the vapour, to rouse patients from fainting fits, has also caused death by suffocation or inflammation of the air-passages.

The vapour of ammonia is readily recognised by its pungent odour, and it is distinguished from the fixed alkalies by the change produced in vegetable colours being dissipated by heat. The *sesquicarbonate* (vulgarly known as hartshorn, volatile salt, or smelling salts) is recognised by its pungent odour, and distinguished from the carbonates of potash and soda by being completely dissipated when heated on platinum foil. It is distinguished from liquid ammonia by effervescing with an acid, and yielding a white precipitate with the salts of lime.

Ammonia is set free from its salts when they are heated with liquor potassæ in a test tube, the vapour being identified by its odour, by its alkaline reaction, and by the dense fumes formed when brought into contact with hydrochloric acid. Ammonia in *organic mixtures* must first be separated by distillation and then identified by its appropriate tests.

Symptoms.—These, as far as they are due to contact, are the same as those caused by potash and soda, and their carbonates; but from its extreme volatility it gains access to the air-passages, and has thus proved fatal in so short a time as *four minutes*.

Post-mortem Appearances.—Signs of violent inflammation in the alimentary canal with separation of the epithelium of the mouth, and inflammatory appearances in the air-passages.

Treatment.—Vinegar and water as an antidote, and the after-treatment proper to the class of irritants.

CHAPTER V.

IRRITANTS.

SALTS OF THE ALKALIES AND EARTHS.

THE carbonates of potash, soda, and ammonia have been already treated of (p. 410). The binoxalate of potash will be examined with oxalic acid; and the iodide of potassium with iodine. The poisons, therefore, which remain are:—

1. Nitrate of Potash. 2. Sulphate of Potash. 3. Bitartrate of Potash. 4. Sulphate of Alumina and Potash. 5. Sulphuret of Potassium. 6. Chloride of Sodium. 7. Chlorides of Lime, Soda, and Potash. 8. Salts of Baryta.

The nitrate, sulphate, and bitartrate of potash, the sulphate of alumina and potash, and the chloride of sodium, are weak poisons, acting as such only in large doses. They are not generally considered poisons, and have consequently been used to discharge worms or to procure abortion. But the sulphuret of potassium is an active and fatal poison, and combines the irritant action of the base with the narcotic property of the sulphuretted hydrogen gas.

I. NITRATE OF POTASH (*Nitre, Saltpetre, Sal Prunelle*).

Poisoning with this substance is generally accidental, it being taken by mistake for sulphate of soda or sulphate of magnesia.

Properties.—It is sold as colourless or nearly colourless crystals, or as crystalline masses; and in white spherical or circular cakes (sal prunelle). It has a salt cool taste, and the familiar property of causing matters with which it is mixed to deflagrate.

Tests.—See nitric acid (p. 403).

Symptoms.—Nitre may be given in such doses as a scruple, two or three scruples, and even half an ounce, without injurious effects. In larger doses of one or two ounces it has acted only as a strong emetic or purgative. But several cases are on record in which doses of an ounce and upwards have produced symptoms of acute irritant poisoning, with profuse discharges of blood by vomiting and purging, and bloody urine. There is extreme prostration of strength, accompanied or followed in some instances by nervous symptoms, such as convulsions, slight trismus, tetanus, and stupor, loss of speech, sensation, and voluntary

motion, and illusions of the senses. In one case there was chorea of two months' duration.

Fatal Dose.—One ounce of the salt has proved fatal, and death has taken place in *three* hours.

Post-mortem Appearances.—Marks of acute inflammation in the stomach and small intestines, with black patches in the stomach, resembling gangrene. In one case there was a small opening in the stomach.

Treatment.—Vomiting, if absent, to be promoted by emetics, followed by the abundant use of diluents: or the stomach-pump may be used. Antiphlogistic remedies may be required to combat high inflammatory action, sedatives if nervous symptoms are present, and stimulants in case of collapse.

II. SULPHATE OF POTASH (*Sal de duobus, Sal Polychrest*).

This salt has proved fatal when administered in large doses. Ten drachms given, in divided doses, to a French lady within a week of her confinement proved fatal in two hours, with the symptoms and post-mortem appearances of irritant poisoning. In a suicidal case, in which Dr. Letheby gave evidence, an ounce and a half caused marked appearances of irritation in the stomach and small intestines.

Tests.—The salt is readily identified by nitrate of baryta, as a test for the acid, and bichloride of platinum as a test for the base.

Treatment.—As for nitrate of potash.

III. BITARTRATE OF POTASH (*Cream of Tartar, Argol*).

In such large doses as two ounces and upwards, this salt is a decided poison. It has destroyed the life of an adult male in forty-eight hours, with the symptoms and post-mortem appearances of irritant poisoning. It is generally found as a white powder, sparingly soluble in water. The solution has a feeble acid reaction. The powder when heated is converted into carbon and carbonate of potash, which latter effervesces with acids. The base may be identified by bichloride of platinum. It may be obtained as a sediment from organic liquids. The *treatment* is by copious demulcents, and by other remedies appropriate to the condition of the system. A dilute solution of the bicarbonate of potash may be given with advantage; as it reduces the bitartrate to the condition of a harmless purgative salt—the neutral tartrate.

IV. SULPHATE OF ALUMINA AND POTASH (*Alum*).

This substance is not often taken as a poison.

Properties.—It is found in commerce as a colourless crystal-

line mass, or in the calcined state as a white mass or powder. It is also met with as iron-alum. It has a sour taste, and yields an acid solution, which is readily distinguished from dilute free acids by evaporation. If a drop of the solution be placed on a slip of glass, it commonly leaves on evaporation a beautiful compound crystal, consisting of straight parallel columns crossed at right angles by short lines, and surrounded by rectangular crystalline forms, blended with regular octahedra, more or less perfectly formed. From saturated or strong solutions of alum the crystals are deposited either as right octahedra or as cubes, and large masses of crystals, consisting of piles of octahedra, either colourless or coloured, are familiar objects in the shops.

Tests.—The sulphuric acid may be detected by the solution of nitrate of baryta; the alumina is thrown down by liq. potassæ, as a white precipitate, soluble in an excess of the precipitant; and the potash may be detected by the chloride of platinum.

Symptoms.—Those of simple irritant poisoning (p. 358).

Treatment.—That of simple irritant poisoning. After emptying the stomach by the stomach-pump or by emetics, lime-water may be given with advantage.

V. SULPHURET OF POTASSIUM (*Liver of Sulphur*).

The alkaline sulphurets are active poisons, containing an irritant base with a narcotic gaseous acid.

Properties.—It is found in the shops in dirty green masses, or in powder of the same colour. It yields a yellow solution, and has a strong odour of sulphuretted hydrogen.

Tests.—On the addition of an acid the gas is disengaged, and produces its characteristic effect on paper moistened with acetate of lead.

Symptoms.—Those of acute irritant poisoning, with the addition of convulsions, or of stupor. The breath, and the matters discharged from the stomach and bowels, have the odour of sulphuretted hydrogen. Death may occur in so short a time as a quarter of an hour.

Post-mortem appearances.—Redness of the stomach and duodenum, and deposit of sulphur on the mucous membrane. The surface of the body very livid. The lungs gorged with dark blood.

Treatment.—Dilute solutions of chloride of soda or lime (bleaching liquids) should be immediately administered. The remainder of the treatment is that of irritant poisoning.

VI. CHLORIDE OF SODIUM (*Common Salt*).

Properties and Tests.—The salt is soluble in water, and the

solution on evaporation yields cubic crystals. The acid is detected by the solution of nitrate of silver, which throws down the white chloride; and the base by the negative reaction with the bichloride of platinum.

Symptoms.—Those of irritant poisoning (p. 358).

Treatment.—As for nitrate of potash (p. 415).

VII. CHLORIDES OF LIME, SODA, AND POTASH (*Bleaching Powders and Liquids*).

The chloride or hypochlorite of lime (common bleaching powder); of soda (Labarraque's or Fincham's liquid); and of potash (Eau de Javelle), are all poisonous.

Properties.—These substances and solutions yield chlorine spontaneously or on adding an acid; and they have a strong odour of the gas; and powerful bleaching properties.

The symptoms, post-mortem appearances, and treatment would be those proper to the class of irritants.

VIII. SALTS OF BARYTA.

Properties.—The chloride of barium is irregularly crystallized in tables. It is permanent in the air, soluble in water, and has an acrid taste. The carbonate is a fine white powder, insoluble in water, but soluble with effervescence in dilute acids, and readily decomposed by the free acids of the stomach.

Tests.—Baryta is precipitated from its solutions as a white carbonate by carbonate of potash, and as an insoluble white sulphate by sulphuric acid or the alkaline sulphates. Oxalic acid does not precipitate baryta from dilute solutions. The acids in combination with the base are easily distinguished: carbonic acid by effervescing on the addition of dilute acids; muriatic acid by nitrate of silver; nitric acid by precipitating the base with sulphate of potash, when nitrate of potash will remain in solution; and acetic acid by the odour of the vapour disengaged on adding dilute sulphuric acid.

Symptoms.—Those of irritant poisoning (p. 358), with the addition of violent cramps and convulsions, headache, excessive debility, dimness of sight and double vision, noises in the ears, and violent beating at the heart.

Post-mortem Appearances. — Those of irritant poisoning (p. 358). In one case, in which death took place in two hours, the stomach was found perforated.

Treatment.—The free use of the sulphate of soda or of magnesia as an antidote, emetics, and the stomach-pump. The after-treatment is that proper to the irritants as a class.

CHAPTER VI.

IRRITANT GASES.

1. Nitrous-acid Gas. (See p. 405.)
2. Sulphurous-acid Gas.
3. Hydrochloric-acid Gas.
4. Chlorine.
5. Ammonia. (See p. 413.)

The irritant gases have the common property of irritating and inflaming the eyes, throat, and whole extent of the air-passages; and in a concentrated form may cause fatal spasm of the glottis.

2. *Sulphurous-acid Gas.*

This gas possesses highly-irritating properties. It is one of the products of the combustion of common coal, and contributes to the fatal result when coal is burnt in close apartments. It is also the chief cause of the irritating gusts which issue from the baker's oven, and contribute to produce the diseases of the chest to which the London bakers are peculiarly liable.

3. *Hydrochloric-acid Gas.*

From experiments made on plants by Drs. Turner and Christi son, and from experiments on small animals by Messrs. Rogerson (see chapter on Poisonous Gases in Christison 'On Poisons') it is evident that this gas is possessed of highly-irritating properties and that if inhaled by the human subject it would destroy life, as certainly as any other of the irritating gases.

4. *Chlorine.*

This gas is largely used in bleaching, and, in the sick room, as a disinfectant. It has highly-irritant properties, and produces violent irritation in the eyes, nostrils, air-passages, and throat. In a case cited by Christison, great relief was obtained by the inhalation of a small quantity of sulphuretted hydrogen gas.

From information collected by Christison, it appears that men who are in the habit of inhaling air impregnated with chlorine become gradually accustomed to its use, though they suffer from dyspeptic complaints and acidity, and lose flesh; but nevertheless many of them attain to an advanced age.

CHAPTER VII.

IRRITANTS.

PHOSPHORUS AND IODINE.

These two poisons, as well as the preparations and compounds of most of the metallic poisons, give rise to such remote effects as cannot be explained by the intensity of their local action, and therefore they might be properly distinguished as *specific irritants*. It will, however, be sufficient for every practical purpose to mention this fact, without placing these words at the head of this and the following chapters.

I. PHOSPHORUS.

Properties.—It is usually found in the shops as long, small, white, translucent cylinders, preserved in water, having the consistence and flexibility of wax, and a crystalline fracture. It is insoluble in water, but soluble in oils, alcohol, ether, and chloroform. It is also remarkably soluble in bisulphide of carbon. After being kept some time in water it becomes covered with a yellowish-white coating. When exposed to the air it gives off white vapours of phosphorous and phosphoric acids, and when heated or rubbed, burns with a yellow flame, and gives off dense vapours. It is luminous in the dark, and has the taste and odour of garlic. A paste consisting of flour, sugar, oil, lard, or butter, and phosphorus, sometimes coloured with Prussian-blue, is sold as a poison for rats; and when mixed with nitre or chlorate of potash, gum, sand, and red lead, or other colouring matter, it is used to tip lucifer matches. It has been given as a medicine in over-doses; is very often taken in France, and sometimes in England, as it exists on lucifer matches; and has been given in substances and liquids of strong colour and flavour as a poison, or as an aphrodisiac.*

Symptoms.—Poisoning by phosphorus is characterized by the variety of its symptoms, and often by their obscure and insidious character. It may occasion three well-defined groups of symp-

* The frequent use of this substance in France, where it now heads the list of poisons, and is given or taken twice as often as arsenic itself, has led to so careful a study of its symptoms, post-mortem appearances and chemical analysis, that it takes up nearly a tenth part of the work of Tardieu and Roussin.

toms, which may be distinguished as—*a. Irritant; b. Nervous; c. Hæmorrhagic.*

a. At the moment of swallowing the poison a disagreeable taste and odour are often perceived, which some compare to garlic, some to that of burning sulphur. There is heat and pain in the throat, swelling of the tongue, and sometimes pain in the pit of the stomach, with discomfort and excitement, and nausea, followed, often after a considerable interval, by vomiting of matters mucous or bilious, rarely bloody. These matters sometimes shine in the dark. Vomiting, when it occurs, affords relief, but it is often altogether absent. Colic pains and diarrhœa, with some tenderness of the belly, sometimes follow. The countenance undergoes little change of expression, and the mind is intact. At the end of twenty-four or thirty-six hours the vomitings cease, the patient goes about as usual, complaining of wandering pains in the limbs and loins. The pulse is small, soft, and slow. This treacherous calm may last for two, three, or four days, or even more, and when the patient seems to have recovered, he may die suddenly without presenting any new symptoms. But generally, on the second or third day, jaundice shows itself with headache and sleeplessness, and retention of urine, which, when drawn off by the catheter, is found tinged with bile, and sometimes albuminous. Both these states may occur in twenty-four hours. Vomitings also occur from time to time, and painful, sometimes involuntary, discharges from the bowels. Acute delirium, followed by fatal coma, lasting from six to twelve hours, terminate the case. In many young infants, vomiting, followed by somnolence and convulsions, are the leading symptoms, and death takes place in from four hours to two days.

b. In this form the symptoms in the throat and stomach are attended by creeping sensations in the limbs, painful cramps, and repeated faintings, with extreme prostration and somnolence, but no fever, and no venereal excitement. The skin is dry, yellow, and marked by erythematous spots. Towards the fifth or sixth day, sometimes later, acute delirium suddenly breaks out, with rigid contraction of the jaw, and convulsions of the limbs, followed by coma, and death in from a week to a fortnight from the swallowing of the poison, rarely later.

c. The symptoms set in as in the previous varieties, but the matters vomited often consist of pure blood, and are succeeded by bloody diarrhœa and tenesmus. The liver is swollen and painful; the heart's beats are feeble; and the weakness extreme. After some days the symptoms improve, but there are still colic pains and some discharge of blood by stool. At the end of three weeks

or a month, discharges of blood occur from the stomach, lungs, nose, ears, womb, and bladder; and fluid bloody spots appear on the surface, and blend on the skin and in the eye with the yellow colour of jaundice. This state of things may continue as long even as five months. Meanwhile the debility increases, and the patient growing more and more anæmic and cachectic may die at the end of as many as eight months, with the nervous symptoms just described. When the poison does not prove fatal, it may leave behind it extreme debility, and partial paralysis—in one case by M. Caussé, incurable palsy of both hands.

Post-mortem Appearances.—When phosphorus is taken in substance, there are bloody or gangrenous spots in the gullet, stomach, and intestines, with swelling and softening of the mesenteric glands. The coats of the viscera are sometimes perforated. When the phosphorus is mixed with other matters, as in the paste, or on the lucifer matches, the internal appearances are such as might occur in the worst forms of sea-scurvy—bloody spots in every organ and tissue, bloody serum in the cavities, bloody matters in the intestinal canal, bloody urine in the bladder. The skin has a yellow tinge. There is marked fatty degeneration in the liver, kidneys, glands of the stomach, heart, and muscles.

As these fatty degenerations are common to the action of phosphorus and of some other poisons, and are present in many maladies, chronic and acute, they can only be taken as signs of poisoning by phosphorus when they occur in a person (and especially in a young person) previously healthy, and dying of the more acute forms of the poisoning.

The contents of the alimentary canal may be found phosphorescent, and when lucifer matches are taken, small fragments of deal, specks of sulphur, or of vermilion or other colouring matter, may be found adhering to the coats of the gullet, stomach, or intestines, or among their contents.

Fatal Dose.—One grain or less.

Fatal Period.—In acute cases as little as four hours. In chronic cases life may be prolonged for several months.

Diagnosis.—When called to a case of poisoning supposed to be by phosphorus, the medical man may be able to ascertain the fact beyond doubt by closing the doors and windows, and examining the mouth and nostrils, person and clothes of the patient, as well as the matters rejected from the stomach or bowels, or things on which they may have been discharged.

Treatment.—There is no antidote to this poison. The stomach-pump or emetics should be at once resorted to, followed by

aperients of sulphate and carbonate of magnesia, and hydrate of magnesia suspended in mucilaginous drinks should be frequently administered. The rest of the treatment will vary with the symptoms present.

Phosphorus in Organic Mixtures.—The best method for detecting the poison is that of Mitscherlich. To the organic matter diluted with water a small quantity of sulphuric acid is added, to neutralize any ammonia that may be present. This is distilled in the dark from a flask, through a tube kept cool by a stream of water. At each condensation of the vapours in the tube a luminous appearance is perceived. The apparatus is similar to that figured at p. 376, but that, in lieu of the central tube, a long glass tube of small diameter, enclosed in an outer tube containing running water, is substituted, and the vessel of water is dispensed with.*

Chronic Poisoning by Phosphorus.

The makers of phosphorus, the manufacturers of congreve matches, the makers of some kinds of vermin-paste, and pharmaceutical chemists, are more or less exposed to the vapours of phosphorus. Those who suffer from such exposure waste away under prolonged dyspepsia and diarrhœa, with hectic fever. The vapour of phosphorus inhaled by those who make lucifer matches causes periostitis, leading to caries of the teeth and necrosis of the jaw. The disease begins with aching in one of the teeth (more commonly of the lower than of the upper jaw), which ceases on extraction of the tooth, but the wound in the gum does not heal; offensive matter oozes from it, and after a time a portion of the alveolus becomes exposed. Sometimes this comes away, bringing with it one or two of the adjoining teeth, and the disease is for the time arrested. More frequently, however, the disease spreads, more bone becomes denuded, the gums grow spongy and retreat from the alveoli, the teeth get loose and fall out, the fetid discharge becomes more copious, and the disease spreads to the adjoining soft parts. At the end of six months, a year, two years, or more, the patient sinks from some exhausting disease promoted by the poisoning, or, having lost by degrees a half, or even the whole of the upper or lower jaw, the patient recovers, subject only to a shocking deformity.†

* After noticing several other proposals including that which they attribute to Reveil, and which avails itself of the ready solubility of phosphorus in bisulphide of carbon, Messrs. Tardieu and Roussin allege that up to this time the only method which can inspire confidence is this method of Mitscherlich. 'Sur l'empoisonnement,' p. 457.

† For a full description of this curious and painful malady, and for sug-

The discovery of the important fact that red, amorphous, or allotropic phosphorus, though possessing the same chemical composition, is not poisonous, may lead to the disuse of common phosphorus for manufacturing purposes. The substitution of chlorate of potash is, however, to be preferred.

II. IODINE.

Properties.—A scaly substance, not unlike iron filings, of a peculiar and disagreeable odour, giving off irritating violet fumes when heated, striking a fine blue colour with a solution of starch, and staining the skin and intestinal canal a yellowish brown, which stain is removed by liquor potassæ. It is found in the shops in substance; as a tincture; and as a compound solution with iodide of potassium as a solvent. It is largely used in medicine as an external application.

Symptoms.—A disagreeable acrid taste, with a sensation of heat, dryness, and constriction in the throat, in the act of swallowing, followed by the symptoms of acute irritant poisoning (p. 358), with the addition of nervous symptoms. The discharges, of a deep yellow tint, or dark blue if mixed with starch-containing food, are often mixed with blood.

In chronic poisoning, produced by the prolonged employment of iodine or its preparations in medicinal doses, the symptoms, in addition to those of irritation of the alimentary canal, are tremors, palpitation, gradual absorption of the testicles, mammæ, and other glandular structures, ptyalism, increase of almost all the secretions, priapism, and enlargement and tenderness of the liver. These symptoms, which are not present in all cases of *iodism*, have been more than once produced by small doses administered for a few days at a time.

Post-mortem Appearances.—Those of acute irritant poisoning, with corrosion (p. 358). Enlargement of the liver.

Treatment.—After the stomach-pump, the free use of a weak solution of carbonate of soda, and of diluents containing starch, such as arrow-root.

Iodine in organic mixtures.—The poison is readily identified by the characters above given. Bisulphide of carbon which dissolves it readily, yielding a pink solution, has also the property of separating it from some of its solutions, and depositing it again on evaporation.

gestions for its prevention, consult Dr. Bristowe's Report on the Manufactures in which Phosphorus is produced or employed, and on the health of the persons engaged in them, in the 5th Report of the Medical Officer of the Privy Council, 1862.

IODIDE OF POTASSIUM (*Hydriodate of Potash*).

Properties.—A crystalline substance, having a peculiar faint odour; white when pure, permanent in the air, and very soluble in water and alcohol; but when impure, of a yellowish colour, and deliquescent. Crystalline form a cube (fig. 72).

Fig. 72.

Tests.—Strong nitric or sulphuric acid turns the crystals brown, and liberates the iodine, which, on applying heat, rises in violet vapours.

In Solution it has the following reactions:—Corrosive sublimate throws down a fine carmine-red iodide of mercury; acetate of lead, the yellow iodide of lead; the subnitrate of mercury, the yellow subiodide of mercury, which gradually changes to a dirty brown; sulphuric and nitric acids change the solution to a brown; and, on the addition of starch, to a characteristic blue. The base may be detected by the bichloride of platinum.

In Organic Mixtures. — Transmit sulphuretted hydrogen through the mixture to convert free iodine into hydriodic acid. Drive off the excess of gas by a gentle heat, add potash in excess, filter, and evaporate to dryness. Place the residue in a covered crucible, and char it at a low red heat; reduce the charred mass to powder, treat it with distilled water, and filter; concentrate by evaporation, and apply the test of starch and sulphuric acid. By this means very minute quantities of the poison may be detected.

Symptoms.—When given as a medicine, in small doses, the hydriodate of potash sometimes acts injuriously, in consequence of peculiarity of constitution. Alarming symptoms have been produced by a few doses of two or three grains, or a single dose of five grains; but the medicine is being constantly given in five-grain doses three times a day to large numbers of patients without producing any bad effects. The symptoms are vomiting and purging, severe griping pains in the abdomen, watering at the nose and eyes, swelling of the face, headache, dryness of the throat, intense thirst, difficulty of breathing, frequent pulse, and great prostration. In less marked cases the symptoms resemble those of a severe cold. Ptyalism is an occasional symptom. In one case, in which I ascertained that no preparation of mercury had been given, all the characters of mercurial salivation were present.

Treatment.—After the prompt removal of the poison by emetics, or the stomach-pump, diluents, with antiphlogistic remedies if necessary.

CHAPTER VIII.

METALLIC IRRITANTS.

I. ARSENIC. II. ANTIMONY. III. MERCURY. IV. LEAD. V. COPPER. VI. ZINC, TIN, SILVER, IRON, BISMUTH, AND CHROME.

I. ARSENIC AND ITS PREPARATIONS.

ARSENIC is by far the most important of the metallic poisons, whether measured by the extent to which it is diffused, the variety of its applications in medicine and the arts, or its use as a poison.

Arsenic and its compounds enter largely into the composition of the earth's crust, as metallic arsenic, arsenious acid, the two sulphides, realgar and orpiment, or as a constituent of several ores of iron, copper, silver, tin, zinc, nickel, and cobalt. Most of the arsenious acid of commerce is prepared from an arsenical sulphide of iron, known as mispickel, or arsenical pyrites; the remainder from the roasting of ores, chiefly of copper and cobalt.

Arsenic has accordingly been found in several soils, in plants grown upon them, and in some mineral waters and running streams; arsenious acid is largely diffused through the air in the neighbourhood of some smelting furnaces, and arsenic acid and the alkaline arsenates are used as mordants, in some dye-works to such an extent as to poison the streams into which they discharge their refuse; and even to taint the water-supply of towns.

As the iron pyrites, or *mundic*, which is so largely used in the manufacture of oil of vitriol, contains arsenic as an impurity, much of the sulphuric acid of commerce is tainted with it; and this being, in its turn, used in the manufacture of nitric, hydrochloric, and other volatile acids, of sulphate of soda, as a preliminary to the making of the carbonate, and for other purposes, many liquid and solid substances in common use in medicine and the arts are impregnated with arsenic. The two metals, zinc and copper, the two acids, the sulphuric and hydrochloric, and the sulphide of iron used in testing for arsenic, have all been found to contain it.

Arsenious acid, the most important compound of arsenic, is much employed in the arts. It is used in the manufacture of

glass, to improve the quality of the "metal," and in making white enamel. Composition candles sometimes contain it. It is employed to prevent "furring" in steam boilers. Shipbuilders mix it with tar to protect timber from worms. It is contained in liquids, powders, and papers for killing rats and vermin, flies and moths. Farmers use it to preserve grain for seed, and as an ingredient in dipping compounds for sheep. Grooms give it to horses to improve their coats, and there is no longer any doubt that some Styrian peasants habitually take arsenious acid in quantities exceeding the smallest poisonous dose.*

The metal arsenic is mixed with lead in small shot.

Preparations of arsenic have been mixed by accident or design with articles of confectionery: arsenious acid with lozenges, orpiment in Bath buns, and Scheele's green with blancmange. This last, or an analogous preparation, is also very largely used in many of the ornamental arts.

Medicines containing arsenic are prescribed for the cure of ague and intermittent disorders, and of obstinate diseases of the skin; and white arsenic, subdivided by mixture with calomel or other suitable vehicle, is applied externally in lupus and cancer.

Arsenious acid enters into two preparations in the British Pharmacopœia, the liquor arsenicalis, or Fowler's solution (gr. iv in fl. ℥j), and the liquor arsenici hydrochloricus (gr. iv in fl. ℥j).

Arsenic acid enters into the ferri arsenias, the sodæ arsenias, and the liquor sodæ arsenatis (gr. iv in fl. ℥j).

The preparations of arsenic most interesting in a medico-legal point of view are, the white oxide or arsenious acid, the yellow sulphide or orpiment, the green arsenite of copper, or Scheele's green, and the arsenite of potash contained in Fowler's solution. Of these the arsenious acid is by far the most important; and must therefore be examined with great care and minuteness.

As all our processes of analysis include the production of the metal arsenic as a means of identification, some account must first be given of its most important properties.

The *metal* arsenic is stated to sublime at 356° Fahr.; but I have found that small quantities of the metal sublime at 230°. The sublimation gives rise to the odour of garlic. When the process is conducted in close vessels, in an atmosphere

* Dr. Roscoe, in a paper read to the Manchester Philosophical Society, Oct. 30, 1860, brought forward conclusive evidence in support of this statement, and adduced well-authenticated instances in which the poison was swallowed to the amount of 4½ and 5½ grains at a time; and Dr. Maclagan has more recently placed the fact beyond the reach of doubt. See his interesting and instructive paper in the 'Edinburgh Medical Journal,' vol. x. p. 200; and letter from Dr. Knapp bearing witness to the swallowing of 7½ grains of arsenious acid. Ibid. p. 669.

of carbonic acid, it settles on cooler surfaces unchanged; but when heated in the air it is deposited as white oxide, or arsenious acid, or as a mixture of the acid with the metal. In common with antimony it combines with nascent hydrogen to form arseniuretted hydrogen, which gas, when heatêd or burned, gives up the pure metal to cooler surfaces; and it shares with several other metals the property of being reduced and deposited on copper boiled in an acid liquor containing any of its preparations.

All these properties of metallic arsenic are displayed in operations on the small scale with the spirit-lamp and reduction-tube. The vapour of the metal has the garlic odour: it is deposited as arsenious acid, when the tube contains atmospheric air; and as pure metal when it is filled with carbonic acid gas: it forms a shining metallic crust, or stain, on white porcelain when the burning jet of arseniuretted hydrogen is directed upon it from Marsh's apparatus; it leaves a similar stain in the tube through which the gas is transmitted, when it is heated by the spirit lamp; and it gives a metallic coating to copper foil boiled in liquids acidulated with hydrochloric acid, according to Reinsch's process. The vapour of the pure unmixed metal is deposited on cooled surfaces as minute globules, which shine by reflected light like those of mercury (fig. 73); but when there is enough air present to oxidize part of the vapour, the globules of metal are blended with the white powder or brilliant crystals of arsenious acid.*

Fig. 73.

ARSENIOUS ACID (*Oxide of Arsenic, Sesquioxide of Arsenic, White Oxide of Arsenic, White Arsenic, Arsenic*†).

In the two years 1837–38, arsenious acid was the ascertained cause of 185 deaths, being as many as those attributed to all the preparations of opium, and many more than those caused by all other poisons. Of these 185 deaths, 112 were ascertained to have been suicidal, 21 accidental, and 12 homicidal; but the last figure is certainly too low.

Since the act of 1851 (14 Vict. cap. xiii.), which restricted the sale of arsenic, and prescribed its admixture with soot or indigo when sold in small quantities, poisoning by arsenious acid has become less frequent, both absolutely and relatively to other poisons. In the five years 1852–56, it gave rise to 27 only of the annual average of 268 deaths by ascertained poisons. In the first period, therefore, the proportion was 1 in 3, or 34 per cent.,

* Refer to a paper by the author, 'On the Production and Identification of Crystals of Arsenious Acid and Crusts of Metallic Arsenic,' in Dr. Beale's 'Archives of Medicine,' No. 111, 1858.

† In some country places it is known as "Mercury!"

in the second period 1 in 10, or 10 per cent. In France arsenious acid takes still higher rank as a poison.

This common use of arsenious acid as a poison will excite no surprise when it is borne in mind that it is as white as flour, that it is tasteless or nearly so, that it may be mixed with articles of food without undergoing or causing any change, that it is very cheap, and that it is largely used, as already stated, for a great variety of purposes.

Arsenious acid is found in commerce as a cake, and as a white powder. The cake, when first sublimed, is nearly transparent, but becomes opaque by keeping, so as to resemble a white enamel with thin transparent striæ. It is the powder that is ordinarily used as a poison. Arsenious acid, in either of these forms, has well-marked physical properties, and may be readily identified by chemical tests.

Properties.—1. Sparingly soluble in water, hot or cold. 2. The solution has a very slight acid reaction. 3. In substance it is tasteless, but its solution or vapour has a very faint sweet taste.* 4. The aqueous solution when slowly evaporated deposits octahedral crystals. 5. It is very soluble in ammonia, hydrochloric acid, and carbonate of potash; and it is deposited from its solutions in ammonia and hydrochloric acid, also as octahedra. 6. It combines with alkalies, forming soluble arsenites. One of these properties, the *solubility*, requires to be more minutely examined.

Solubility.—An ounce of cold water dissolves from half a grain to a grain; boiling water poured on the poison retains on cooling a grain and a quarter to the ounce; and water boiled for an hour on the powder 12 grains to the ounce. The presence of organic matter renders the poison less soluble. (Taylor.)

Tests.—We may have to identify the poison—1. *In substance.* 2. *In solution.* 3. *In organic liquids.* 4. *In the fluids and solids of the body.*

1. *Arsenious Acid in Substance.*

a. Heated by the spirit lamp on platinum foil, it sublimes unchanged, as a white vapour. *b.* Heated in a reduction-tube, it is deposited as an amorphous powder, or as octahedral crystals. *c.* Moistened by liquor potassæ it undergoes no change of colour. *d.* Moistened by sulphide of ammonium, no immediate change

* A lad took from the mouth of a bottle as much arsenious acid as would cover a sixpence, and told me that it tasted like flour. Otto Tachenius says, "that after many sublimations of arsenic, on opening the vessel, he sucked in so grateful and sweet a vapour, that he greatly admired it, having never experienced the like before." See Baker's 'Employment for the Microscope,' p. 133.

takes place; but when the excess of ammonia has passed off, a canary-yellow sulphide of arsenic remains. This change may be brought about directly by heat, or by adding acetic acid. *e.* When arsenious acid mixed with charcoal is dropped into a reduction-tube and heated, the metal is reduced and volatilized; and deposited on the cooler part of the tube as a shining metallic crust. *f.* The sublimed metal has the odour of garlic.

The two tests of sublimation and reduction must be more exactly described, and their results more minutely examined.

Sublimation.—It has just been stated that arsenious acid dropped into a reduction-tube and heated by the flame of a spirit-lamp, becomes a white vapour, which deposits on the cooler part of the tube an amorphous powder, or octahedral crystals. But as the crystals are characteristic of the poison, not the white amorphous deposit, it is necessary to explain by what mode of manipulation the crystals may be obtained. Now experience has shown that in order to get characteristic crystals the white vapour must be received on a heated surface. On a cool surface it is deposited as an amorphous powder.

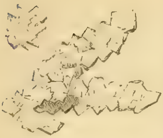
The process of sublimation is usually performed in a reduction-tube of about the size and length shown in fig. 76, p. 430. After drying the tube by passing it repeatedly through the flame of the lamp, the arsenious acid, placed in a short tube of smaller size, is dropped in, and the flame of the lamp applied, so as to envelope the lower third of the tube. By the time that the inner tube is so heated as to sublime its contents, the temperature of the outer tube will be favourable to the deposit of distinct crystals.

The subliming temperature of arsenious acid is variously stated at 370° to 400° Fahr., but I have ascertained, both by the method explained at p. 385, and by placing fragments of arsenious acid in small reduction-tubes and plunging them into a sand-bath with the thermometer, that the real subliming point is at or about 280° Fahr.

The crystals of arsenious acid obtained by this coarse method of sublimation also result from the oxidation of the metal arsenic, as a constituent part of tests yet to be described; and as these crystals always furnish a very important means of identification, their shape and characteristic properties should be well understood.

The Crystals of Arsenious Acid are remarkable for brilliancy and permanence. They are almost always distinct and separate, except when superimposed; occasionally they are grouped in rings; but they rarely form compound crystals of any definite shape. The crystals depicted in fig. 74 are extremely uncommon. They were obtained by sublimation in a small tube; and resemble the compound crystals of alum.

Fig. 74.

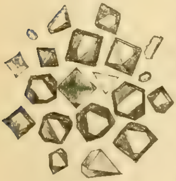


The prevailing form of the crystals of arsenious acid is the regular octahedron. Their less common forms the rhombic dodecahedron, rectangular prism, and plates of various shape and thickness. For an account of the microscopic appearances of the entire crystals, the half crystals, the macles or twin crystals, and other exceptional forms, see p. 388 et seq.

Sometimes (probably from insufficient heat) all the crystals assume irregular and confused forms, and some few specimens consist almost wholly of the deep triangular plates which have been mistaken for *tetrahedra* (a form that never occurs), while in others again plates of every size, shape, and thickness abound.

Some of the many forms which the crystals of arsenious acid assume are shown in fig. 75, as well as in figs. 78 and 79, where they are mixed with scattered globules of metallic arsenic; also in the mixed crust of arsenious acid and metallic arsenic, as seen by reflected light in fig. 77.

Fig 75.



Reduction.—Arsenious acid, well mixed with about four times its bulk of finely powdered recently ignited charcoal, is introduced into the tube, fig. 76, at *a*, with the precautions described in speaking of the process of sublimation, only that it is not necessary to heat the middle portion of the tube. The tube being held at an angle, and the flame of the spirit-lamp steadily applied at *a*, the metal rises in vapour, with the odour of garlic, and is deposited from a quarter to half an inch above the mixture, as a dark brown or black ring, *b*. As the vapour quickly attracts oxygen from the air, it is readily oxidized: so that the ring is always a mixture, in variable proportions, of metallic arsenic and arsenious acid; the metal chiefly at the lower part of the ring wearing the appearance of a mirror; the middle portion containing a large admixture of arsenious acid; and the upper part consisting almost wholly of it. By cautiously applying the flame of the lamp

Fig. 76.

to the lower part of the ring, it may be rendered more compact and more distinctly metallic; and by driving the crust repeatedly up and down the tube, it may be wholly converted into crystals of arsenious acid.

When this reduction is performed with proper precautions (using a tube of green or German glass*), taking care that the mixture of arsenious acid and charcoal, and the tube itself, are free from moisture, so that the mixture may not be driven up into the tube; taking equal care to introduce the mixture so as not to soil the tube; very satisfactory results are obtained. The mixed crusts cannot be mistaken for globules of mercury; nor for the crust obtained by the same process from the white hydrated oxide of cadmium, as the anhydrous oxide of cadmium blended with the crust has a brown, green, or yellow colour.

But as it might be alleged that the crust obtained by this process of reduction does not present such distinct characters as to justify a witness in affirming that it is due to arsenic and to nothing else, we proceed to obtain the crystals of arsenious acid in one of two ways. The sealed end of the tube containing the residue of the charcoal is drawn off, and the metallic crust driven up and down the tube till it is wholly changed into crystals of the oxide; or the sealed end of the tube, as well as the part free from deposit, are filed off, and the part containing the crust, being folded in paper, is broken into small fragments, which are introduced, with like precautions, into a second reduction-tube, and the crust converted into arsenious acid by heat.

But this mode of procuring a crust of metallic arsenic from arsenious acid and charcoal, and crystals of arsenious acid from the crust itself, is open to two classes of objections. The method itself is wanting in delicacy, and encumbered by precautions; and the results present themselves in a form very unfavourable for examination by the lens and microscope, especially when we are dealing with very small quantities of the metal or its oxide. These objections are obviated by the use of the simple apparatus (fig. 45) described at p. 383.

The mixture of arsenious acid and charcoal is first dropped into the clean and dry specimen-tube (a); the disk of glass (c) is then dried in the flame of the spirit-lamp, and, when cool, is placed over the mouth of the tube. The point of the flame is then steadily applied to the bottom of the tube. The vapours of the metal when first disengaged combine with the oxygen of the air contained in the tube, and arsenious acid is re-formed, and

* This is to guard against the possibility of the lead which enters into the composition of the more fusible English glass being reduced in the glass itself.

deposited on the under surface of the glass disk, as an amorphous powder, or in glittering crystals, according to the temperature. The after-deposit consists of globules of the metal.

The crust in this case, then, as in the usual process of reduction, is a mixture of metallic arsenic and arsenious acid, and when examined by the lens, or microscope, by reflected light, has the appearance shown in fig. 77, where the sparkling triangular facettes of the octahedral crystals of arsenious acid are shown projecting through a layer of metal. A third form assumed by some of the thinner crusts, and by the circumference of the thicker ones,

Fig. 77.

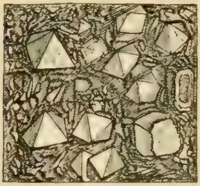
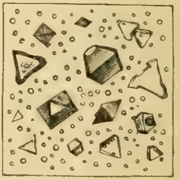


Fig. 78.



consists of crystals of arsenious acid interspersed with distinct globules of metallic arsenic, as in figs. 78 and 79. The thinnest crusts of all are iridescent, and may be resolved, under the higher powers of the microscope, into aggregates of small globules. Crusts of pure unmixed metal, presenting under the microscope the appearances shown in fig. 80, may be readily

Fig. 79.

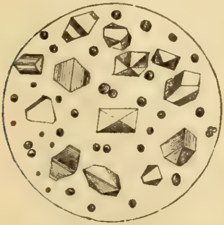
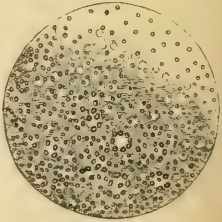


Fig. 80.



obtained by covering the mixture of arsenious acid and charcoal with a layer of dried bicarbonate of soda, so as to fill the tube with an atmosphere of carbonic acid gas. See also fig. 73, p. 427.

The appearances shown in figures 77, 78, and 79, prove conclusively the presence of arsenic. Those presented by the unmixed metal in fig. 80 are less conclusive, as the globules are sometimes not to be distinguished from those of mercury. Hence it may be necessary in the case of the purer crusts of arsenic, and expedient in other cases, to confirm the evidence afforded by the microscopic characters of the metallic or mixed crust, by converting the metal into arsenious acid. With this view the portion of glass bearing the crust should be cut into narrow slips with a writing diamond, and the slips being dropped into a specimen-tube (fig. 45), must be treated in the manner just described. The glass disk will be covered with glittering crystals, or with a mist which can be resolved, under the higher powers of the microscope, into groups of octahedra.

It may be well to state that the metals cadmium, selenium, and tellurium are also sublimed by the heat of a spirit-lamp; that selenium is deposited as globules, and tellurium sometimes converted into crystals of telluric acid. But crusts of selenium have the colour of port wine, the crystals of telluric acid are needles, and the metallic crusts of cadmium and tellurium are not globular: so that the mixed crusts of arsenic cannot be confounded with any other result of sublimation.

There is still one method of procedure specially applicable to such small quantities of arsenious acid as the thousandth of a grain. If, on evaporating a drop of liquid supposed to hold arsenious acid in solution, a white amorphous, or obscure crystalline stain is left, we may test it in one of two ways.

1. By the simple process described in p. 384 (fig. 47).

The disk of glass being dried and heated in the flame of the spirit-lamp, and supported on the glass ring, as there described, a mist will soon form, which, when examined by the microscope, will be found to consist of crystals of arsenious acid. In this way $\frac{1}{1000}$ grain arsenious acid may be identified without difficulty, and even $\frac{1}{5000}$ grain be found to yield characteristic results.

2. Take a fragment of microscopic glass, and mark it with a writing diamond, so that when broken it may yield narrow slips. Place a drop of the solution on the glass, let it dry, and then break the glass. Introduce the slips into the tube (fig. 48, p. 384) in the manner described, and proceed according to the instructions given. The narrow part of the tube will contain crystals of arsenious acid. In this way, too, such small quantities of the poison as the $\frac{1}{1000}$ grain may be detected with certainty, and less than $\frac{1}{5000}$ grain where the reduction is carefully and skilfully performed.*

* To obtain these minute quantities proceed as follows:—Weigh a grain of

These two methods of procedure are equally applicable to the reduction of the metal: the first to the stain of metallic arsenic obtained by Marsh's method on the slab of white porcelain; the second to the mixture of arsenious acid and charcoal. By the first method the stain will be sublimed and deposited as arsenious acid: by the second a crust will be obtained; the first part of which will generally be found to consist of metallic globules, the second of crystals of arsenious acid.

2. *Arsenious Acid in Solution.*

There are several tests for arsenious acid in solution:—Three applied as liquid, and known as *liquid tests;* one as gas, distinguished as the *gaseous test;* a fifth is the well-known *Marsh's test;* and a sixth the now equally well known test of *Reinsch.*

1. *The Liquid Tests.* — These are three in number:—the ammonio-nitrate of silver, the ammonio-sulphate of copper, and sulphuretted hydrogen water. *a.* Ammonio-nitrate of silver.* This throws down a rich yellow arsenite of silver, which, on exposure to light, changes to dingy brown. *b.* Ammonio-sulphate of copper† causes a precipitate of the bright green arsenite of copper. *c.* Sulphuretted hydrogen water throws down the yellow sulphide of arsenic. The sulphide of ammonium produces no immediate effect, but after a long interval, or on the addition of a few drops of acetic acid, causes the same precipitate.

These tests are supposed to be applied in succession to a clear colourless liquid believed to contain arsenious acid, and so applied, are free from objection; but it should be understood that a solution of phosphoric acid yields with ammonio-nitrate of silver a yellow precipitate, as an alkaline phosphate does with the nitrate; and that a decoction of onions gives with the copper solution a green precipitate. As these liquid tests are only used as trial tests, or to prove that a white powder or colourless crystals obtained from the oxidation of a ring of metal really consist of arsenious acid, these objections find no place.

Gaseous Test.—This test, too, is supposed to be applied to a

arsenious acid in an accurate balance. Dissolve it in a thousand minims of distilled water. Take up the solution with a *pipette* furnished with a small opening, or use the stoppered drop bottle (fig. 42, p. 381), which I recommend for all solutions and tests used in delicate chemical manipulations. Ascertain how many drops from the point of the pipette are equivalent to a minim. Say that there are three drops to a minim, then the stain left by the evaporation of a single drop will consist of $\frac{1}{3000}$ grain arsenious acid.

* Formed by adding liquor ammoniæ to a strong solution of nitrate of silver, till the brown oxide of silver at first thrown down is nearly redissolved.

† Formed by adding liquor ammoniæ to a solution of the sulphate of copper, till the bluish-white hydrated oxide of copper is nearly redissolved.

clear colourless liquid. Having ascertained that it has no decided acid or alkaline reaction, we slightly acidulate with acetic acid, and transmit the sulphuretted hydrogen gas through the liquid. If it contains arsenious acid, it soon assumes a rich golden yellow tint. If the quantity of the poison is considerable, a precipitate of the same colour is formed; but if it is in small quantity, the precipitate is not formed till the excess of gas has been expelled by heat, and the liquid has been left at rest for several hours. The only other substances which yield with sulphuretted hydrogen a yellow precipitate are the peroxide of tin and cadmium, both of very rare occurrence, and easily distinguished. The sulphide of antimony is orange-coloured. The presumption, therefore, is strong in favour of arsenic, and may be converted into certainty by collecting and testing the precipitate, or by applying the ammonio-nitrate of silver and the ammonio-sulphate of copper to other portions of the same liquid.

The precipitated sulphide of arsenic having been allowed to subside, is to be carefully collected, washed, and dried, and submitted to a process of reduction differing from that already described when speaking of arsenious acid only in the substitution for charcoal of a flux containing an alkali. That usually employed is the *black flux* formed by incinerating a mixture of one part of nitrate of potash with two of the bitartrate. But incinerated acetate of soda, or a mixture of one part of cyanide of potassium with three parts of carbonate of soda, previously well dried, is to be preferred. If this last flux is used it should be in the proportion of one of the sulphide to twelve of the flux. The metallic crust obtained by this process of reduction is found to be a mixture of metallic arsenic, arsenious acid, and undecomposed sulphide.

In dealing with minute quantities of the sulphide, the method of reduction by the capillary tube (fig. 48, p. 384) should be employed, followed, if the quantity be sufficient, by that described at p. 383 (fig. 45).

The sulphides of cadmium and tin are thrown down immediately by sulphide of ammonium, but the sulphide of arsenic not till the ammonia has been dissipated or neutralized by an acid. The sulphide of arsenic is very soluble in ammonia, those of cadmium and tin insoluble, the sulphide of arsenic yields a distinct metallic sublimate, while the sulphide of tin yields none, and the sulphide of cadmium gives the sublimate described at p. 431.

When the precipitated sulphide is not pure in colour or free from organic matter, it should be dissolved in ammonia, and again thrown down by hydrochloric acid.

The gaseous test, then, properly applied, and followed by the

reduction of the metal from the sulphide, gives certain evidence of arsenic. It is unnecessary, though for medico-legal purposes desirable, to convert the sublimed metal into crystals of arsenious acid.

Marsh's Test.—This ingenious and valuable test was proposed by Mr. Marsh, of Woolwich, about the year 1835. He employed two forms of apparatus; the one (fig. 81) consisted of a tube bent in the shape of the letter J, the long leg being twice the length of the shorter one, and open, and the latter furnished with a stop-cock terminated by a nozzle with a minute bore. Hydrogen was generated in this apparatus by pure zinc and dilute sulphuric acid, to which a portion of the liquid containing arsenic was added. When the arseniuretted hydrogen had filled the smaller leg of the tube the stop-cock was opened, and the jet of gas inflamed. On holding over the flame a piece of glass or porcelain, a distinct metallic ring was deposited upon it. For larger quantities of liquid Mr. Marsh used

Fig. 81.

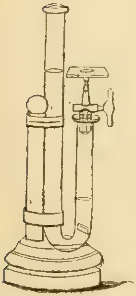


Fig. 82.

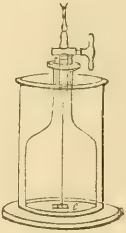
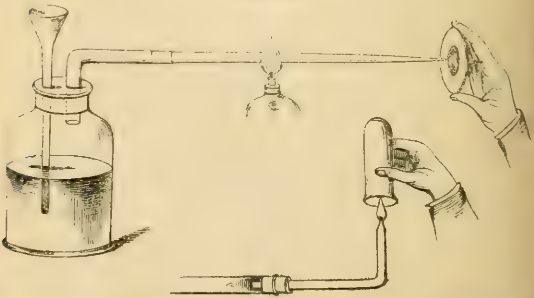


Fig. 83.



the apparatus depicted in fig. 82.* Many alterations and modifications of Marsh's apparatus have been since suggested,

* For an account of the apparatus employed by Mr. Marsh, and the results obtained, refer to the 'Transactions of the Society of Arts,' vol. li. 1835-6.

of which fig. 83 represents by far the most convenient form. The apparatus consists of a wide-mouthed bottle with a closely fitting cork, pierced for two tubes, of which the one, furnished with a funnel, dips beneath the liquid, and the other bent nearly at right angles, but sloping slightly towards the bottle, descends a short distance into the vessel. This tube is furnished with a cork for the reception of a detached horizontal tube of glass free from lead, and drawn out at its extremity into a point with a small aperture.

In this apparatus hydrogen is generated by pure zinc and dilute sulphuric acid, and the action is continued till the atmospheric air is completely expelled, and all risk of an explosion avoided. The flame of a spirit-lamp is then steadily applied for ten or fifteen minutes to the horizontal tube. If there is no deposit we conclude that the zinc and sulphuric acid do not themselves contain arsenic. Having ascertained this, we pour into the funnelled tube part of the liquid supposed to contain arsenious acid, and immediately reapply the spirit-lamp to the horizontal tube. If the liquid contain arsenious acid, a metallic deposit takes place in the tube half an inch or more from the part to which the flame is applied. The horizontal tube should be at least five or six inches long, so that we may obtain two such crusts at least. Having procured these, we light the hydrogen as it issues from the end of the tube, and obtain one or two deposits on slips of porcelain, and others on disks of crown glass. A very minute quantity of arsenic suffices for both these purposes. We may then continue to apply the flame of the lamp to the horizontal tube, till the absence of stain from a fragment of glass held before the jet proves that the metal is exhausted. The spots thus obtained consist either of arsenic or of antimony.

The evidence afforded by the stains thus obtained may be confirmed by bending the horizontal tube at right angles and holding a wide test-tube over the flame. The tube will be coated with arsenious acid resulting from the oxidation of the metal, and to its contents, dissolved in a small quantity of distilled water, we may apply the liquid tests (fig. 83).

The round stains on the surface of porcelain have the following distinctive properties:—

a. The arsenical stain has every variety of metallic lustre, from that of copper to that of steel, but it never wears the sooty appearance proper to most crusts of antimony. *b.* The arsenical stain is much more readily dissipated by the heat of the spirit-lamp, and gives out the garlic odour.* *c.* The two stains are

* This test may be applied as follows:—Procure a crust of arsenic and one

characteristically affected by several liquid and gaseous reagents, from which we select three, the first two as tests by simple solution, the last as a test by solution followed by a characteristic coloured residue. The first of these tests was suggested by Bischoff, the second by the author ('Medical Times,' July, 1847), the third also by the author in the last edition of this work.

1. The arsenical stain is rapidly dissolved by a solution of the chloride of lime (bleaching liquid) which does not affect the antimonial stain. 2. The antimonial stain is less speedily, but at length completely dissolved by a solution of the protochloride of tin, which does not dissolve the arsenical stain. 3. The antimonial stain is rapidly dissolved by the sulphide of ammonium; the arsenical stain slowly and imperfectly. The solution of the antimonial stain, when dry, leaves an orange-coloured spot of sulphide of antimony, while the imperfectly-dissolved arsenical stain presents a light lemon-yellow spot of sulphide of arsenic mixed with portions of undissolved metal.

The following are other modes of distinguishing these stains:—1. The vapours of iodine and phosphorus; 2. Tincture of iodine; 3. Nitro-muriatic acid followed by a solution of nitrate of silver to the dried spot. But the three tests of chloride of lime, protochloride of tin, and sulphide of ammonium are very satisfactory, while the last-named test has the peculiar advantage of combining a marked difference of solubility with highly characteristic and permanent appearances in the dry spot.

The larger and thicker stains of arsenic may also be readily identified. Globules of metallic arsenic may be seen by the higher powers of the microscope on the disks of glass (fig. 80), or they may be transferred from the slab of porcelain to a glass disk by the method described at p. 384, and illustrated in fig. 47. The disk of glass will be found covered with octahedral crystals; or, if the cell is very shallow, with globules of the metal, or the two combined.

The stains of antimony and arsenic in the tube also present some remarkable differences. The antimony is deposited close to the point to which the heat is applied, and on both sides of the flame (B, fig. 85); the arsenic at some distance from it (A, fig. 84.) When heated, the antimony volatilizes very slowly, the arsenic quickly; the arsenic has often a nut-brown or copper colour, the

of antimony on the ends of two oblong porcelain slabs. Obtain two stains at the other ends of the slabs from the liquid under examination; apply the flame of the spirit-lamp steadily to the centre of the porcelain between the two stains. If there is an arsenic stain at one end, and an antimony stain at the other, the first will soon contract under the heat, and ultimately disappear, before the other shows any signs of being affected by it.

antimony the lustre of tin. Of these properties the first and second are highly characteristic; but the colour of the crusts is less constant; for though antimony rarely presents the distinct

Fig. 84.
A

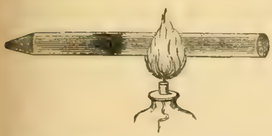
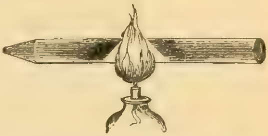


Fig. 85.
B



copper colour of arsenic, nor arsenic the tin-like lustre that belongs to most crusts of antimony, crusts of antimony and arsenic may happen to resemble each other very closely in colour, though not in shape or position. The effect of heat is quite decisive; for while the crust of antimony moves slowly under the flame of the spirit-lamp, and undergoes no remarkable change, the crust of arsenic is easily dissipated, and readily converted into characteristic crystals of arsenious acid. The crusts of arsenic and antimony may also be readily distinguished by detaching the horizontal tube, and transmitting a stream of dry sulphuretted hydrogen gas through it, at the same time chasing the metal, by the flame of the lamp, in a direction opposite to the stream of gas. The antimonial crust changes its place slowly and with difficulty, and gradually assumes, but only in part, the characteristic orange hue of the sulphide; while the stain of arsenic is readily driven from point to point as a light lemon-yellow crust of sulphide.

Some precautions are necessary in using Marsh's test. To guard against explosion, the gas should be generated freely at first, but less briskly when adding the suspected liquid; for the smallest addition of another metal occasions a violent extrication of gas. The first violent action having subsided, the jet should be lighted; and the absence of arsenic (in other words the purity of the zinc and sulphuric acid) ascertained by repeatedly holding a clean surface of porcelain to the jet, as well as by steadily applying the flame of the spirit-lamp to the horizontal tube for several minutes. If there is no stain on the porcelain or in the tube, the suspected liquid may be added drop by drop, the flame being kept all the time steadily applied to the horizontal tube. A few stains should also be obtained on porcelain and on glass. If there should happen to be much froth, a small quantity of spirits of wine may be poured into the funnelled tube.

Reinsch's Test.—Put the liquid containing arsenic into a test-tube, and add about the eighth of its bulk of pure hydrochloric acid, drop into the tube a narrow short slip of clean copper foil, and heat the liquid to the boiling point. If the slip of copper is speedily tarnished by the liquid, other slips may be introduced one by one, until the copper retains its colour. The slips are then to be removed from the liquid, washed in distilled water, and dried at a low temperature. The metal arsenic will be found to form an iron-grey coating, adherent if in small quantity, but readily separating if more copious. A single slip if thickly coated (or several slips if merely stained) is then to be introduced into the capillary reduction-tube (fig. 48), with the precautions described at p. 384. Minute crystals of arsenious acid, readily identified under the microscope, will be found in the capillary part of the tube. If characteristic results are obtained by this process, other slips may be similarly treated in the manner described at p. 383, and illustrated in fig. 45, or by the method figured and described in fig. 47, p. 384. The crystals of arsenious acid, being upon a flat surface, can be readily examined by the microscope.

By either of these methods satisfactory results should be obtained with the $\frac{1}{1000}$ grain of arsenic, and in skilful and practised hands with the $\frac{1}{5000}$ grain.*

Certain precautions must be taken in employing this test. As hydrochloric acid may contain arsenic, and as specimens of copper, even many of those thrown down by the electrotype process, also contain it, the copper must be first boiled in the dilute hydrochloric acid. If it is untarnished, the acid may be considered pure; and if the copper itself, when boiled in the acid liquor supposed to contain arsenic, is not dissolved, and does not impart a green colour to the liquid, the copper may be used with safety. It is only when the liquid which is being tested dissolves the copper, that the impurity of the metal can interfere with the result. In order, however, to guard against both fallacies and objections, a copper of ascertained purity should be used.

The process of sublimation which constitutes the second part of the test is necessary because other metals as well as arsenic yield metallic deposits: solutions containing mercury and silver

* To obtain these small quantities for experiment, prepare a thousand small slips of copper, and boil them in an ounce of distilled water acidulated with hydrochloric acid, and holding in solution $1\frac{1}{3}$ grain of arsenious acid. The slips will be coated with metal, and, if equally covered, each would carry $\frac{1}{1000}$ grain. Experiment successively with a slip, and with fractional parts of a slip, up to a fifth, or less.

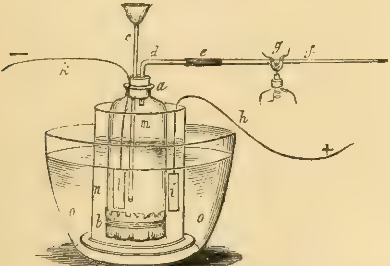
without boiling, and those containing antimony, bismuth, tin, and lead, on applying heat. Alkaline sulphides also tarnish the metal.

These metallic deposits differ in appearance; but not so as to dispense with the use of further tests.

As it is very important that these and similar statements respecting the detection of minute quantities of arsenic, or of other poisons, should not be discredited, refer to what is said on this subject at p. 379.

Galvanic Test.—My colleague, Professor Bloxam, advocates the method of electrolysis as the least objectionable means of generating arseniuretted hydrogen and procuring crusts of metallic arsenic. He first made use of a simple modification of the J-tube fig. 81, p. 436, but afterwards preferred an apparatus of the form shown in the annexed engraving, in which *m*

Fig. 86.



is a two-ounce bottle, the bottom of which is replaced by vegetable parchment *b*, secured by thin platinum wire. The cork *a*, carries a funnelled tube *c*, a small tube *d*, bent at right angles, and connected by a caoutchouc tube *e*, with a drawn-out reduction-tube *f*; and it is pierced by a platinum wire *k*, suspending a plate of platinum-foil *l*. The wire is connected with the negative pole of a galvanic battery. This bottle is placed in a glass *n*, a little larger than itself, and into which the positive plate *i*, attached to the wire *h*, of the battery is introduced. The apparatus is placed in a larger vessel, *o o*, filled with cold water. An ounce of dilute sulphuric acid (1 acid to 3 water) is then poured into the bottle, the poles are connected with the battery, and hydrogen gas is generated till all fear of an explosion ceases. The shoulder of the reduction-tube at *g* is then to be heated to redness for fifteen minutes, to ascertain the purity of the acid.

The liquid to be tested is then introduced through the funnelled tube *c*. Frothing is prevented by adding a drachm of alcohol. The metal arsenic is reduced in the horizontal tube at *g*, as in the modern form of Marsh's apparatus.

This method supersedes the use of zinc in generating the arseniuretted hydrogen, and thus excludes one possible source of fallacy; and it is very delicate. It was successively applied in a series of experiments with quantities of arsenious acid varying from the $\frac{1}{100}$ to the $\frac{1}{1000}$ grain, a characteristic arsenical mirror, the alliaceous odour, and a shining ring of crystals of arsenious acid, being obtained in each instance.*

3. *Arsenious Acid in Organic Liquids.*

As arsenious acid is very insoluble in water, and still more so in organic liquids, the poison may sometimes be obtained in a solid form by diluting with distilled water, and allowing the powder to subside. It may also be found adhering to the mucous coat of the stomach, from which it may be detached. The solid arsenious acid obtained in these ways may be treated in the manner described at p. 439.

If there is no solid arsenious acid in the organic liquid, the poison may still be diffused through it, or dissolved in it; in which case the liquid must be rendered slightly alkaline by liquor potassæ, and then carefully evaporated to dryness over a water-bath. By this means most of the organic matter is coagulated, so that, by boiling the residue in distilled water, a liquid is obtained which will pass the filter; and may be treated as arsenious acid in solution by any of the methods described at p. 434. This mode of procedure is to be preferred when time is no object, and there is reason to believe that the quantity of the poison is considerable. In other cases the process presently to be described must be employed. The solid matters that remain on the filter must be preserved, so that if we fail to procure evidence of arsenic from the filtered liquid, it may be treated by the methods now to be described as applicable to the solids and fluids of the body.

4. *Arsenious Acid in the Solids or Fluids of the Body.*

As there are cases of poisoning by arsenic, in which the poison is entirely expelled during life, so that no trace of it can be found

* On the application of Electrolysis to the detection of the poisonous metals in mixtures containing organic matters. ('Quarterly Journal of the Chemical Society,' 1860.) For information concerning the fallacies that may attach to the processes of Marsh and Reinsch, consult this valuable paper; also one by Wm. Odling, M.B., on some failures of Marsh's process for the detection of arsenic, and Dr. Taylor's 'Facts and Fallacies,' &c., in 'Guy's Hospital Reports,' 1860.

in the stomach after death, it is most important to be able to detect it in the fluids or solids to which it has been conveyed by absorption.

All the methods which have been proposed for effecting this object consist of three essential parts:—The destruction of the animal matter so as to obtain a liquid which will pass the filter; the reduction of the poison to the metallic state by Reinsch's or Marsh's method, or by the method of electrolysis, and the complete identification of the metal.

For the destruction of the animal matter four principal methods have been proposed—one by nitrate of potash; a second by nitric acid; a third by sulphuric acid; and a fourth by hydrochloric acid. The last of these methods is recommended by its simplicity, as well as by the fact that the acid employed is the same that is used in Reinsch's test.

The following process, proposed by Fresenius and recommended by Professor Bloxam, has the great advantage of presenting the poison in the convenient and manageable form of arsenious acid.

If the organic matters are solid, they must be finely divided and brought to the consistence of thick gruel by mixture with water. If already in a liquid state, we proceed at once to digest them for an hour, in a porcelain dish over a water-bath with about half an ounce of hydrochloric acid, adding powdered chlorate of potash occasionally till the organic matters are disintegrated. The resulting coloured liquid is then to be filtered off, evaporated over the water-bath to about an ounce, poured into a flask, and a few drops of a strong solution of bisulphite of soda added to it till it smells strongly of sulphurous acid. The flask is then heated in a water-bath until this odour ceases. The resulting solution, mixed with at least an equal bulk of water, may be examined for arsenic by any or all of the methods already described.

Quantitative Analysis.—The quantity of arsenious acid is best determined by the use of the pure sulphide obtained from a measured portion of the filtered liquid: 100 grains of sulphide nearly correspond to 80 grains of arsenious acid.

When the body of a person supposed to have been poisoned by a preparation of arsenic, is disinterred for the purpose of analysis, and the poison is detected in the stomach, in the solid textures, or in the fluids of the body, it is sometimes alleged that the arsenic contained in the surrounding soil was dissolved in water and conveyed into the body. To meet this allegation it is deemed necessary to analyse a portion of the soil. One or two pounds are first treated with boiling water, and the filtered liquid, reduced

by evaporation to a convenient quantity, is tested by Reinsch's process. If this gives no indication of the presence of arsenic, the soil is treated with one part of hydrochloric acid to ten of water. The lime and iron dissolved by this means are thrown down by adding bicarbonate of potash in excess, and the resulting liquid, filtered and reduced as before, is examined by Reinsch's test.

The following facts bearing on the value to be attached to the detection of arsenic in the dead body require to be borne in mind:—

a. Arsenic may be detected in the dead body after such long intervals of time as seven and ten years.

b. Arsenious acid, usually found attached to the coats of the recent stomach as a white powder or paste, is converted into the yellow sulphide by the sulphuretted hydrogen generated by putrefaction.

c. Preparations of arsenic preserve dead animal matter.

d. Orfila affirmed that arsenic is a natural constituent of the body itself; and that it may be discovered both in the fleshy parts of the body and in the bones. But subsequent researches of himself and others have shown that there was in his first experiments some source of fallacy.

e. Arsenic when contained in the soil of cemeteries is generally, if not always, in an insoluble form, in combination with iron or lime.

f. Preparations of arsenic, whether taken in single large doses, or in repeated small ones, are absorbed into the blood, and may be found in the textures and secretions; and they are only slowly eliminated from the body. The limit usually stated for the complete elimination of arsenic from the human body is three weeks; but it has been extended to a month by M. Bonjean.*

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—In most cases the symptoms set in within an hour of the swallowing of the poison, with burning pain at the pit of the stomach increased by pressure, nausea, and vomiting renewed by the act of swallowing. The pain soon becomes more diffuse, and there is swelling and tenderness of the belly, with diarrhœa, tenesmus, and dysuria. After the setting in of vomiting, if not previously, there is a sense of constriction in the throat, with intense thirst, inflammation and smarting of the eyes, headache, violent beating of the heart, frequent pulse, quick catching respiration, extreme restlessness, great debility, cramps in the legs, and convulsive twitchings in the extremities. In the majority of cases the mind is intact. When the poison proves

* Ranking's 'Half-Yearly Abstract,' vol. iii.

rapidly fatal, death commonly takes place by collapse, or by coma; in more chronic cases, the patient dies exhausted by the violence of the irritative fever, or after a long train of nervous symptoms terminated by convulsions. Patients who recover are either restored to perfect health, or they suffer from indigestion, from prolonged weakness or palsy of the limbs, or from epileptic fits.

But cases of poisoning by arsenic present the greatest possible variety in the character, combination, and severity of the symptoms, and exceptions and anomalies of the most perplexing kind.

In one considerable class of cases, the symptoms are those just detailed in an aggravated form. The vomiting is incessant; the pain in the pit of the stomach most acute, and increased by the slightest pressure; the mouth, tongue, and throat are red, hot, and swollen; the eyes bloodshot; the countenance flushed; the thirst excessive; the diarrhœa profuse, and attended with tenesmus and discharges of blood; the belly acutely painful and tender, and much swollen; the urine suppressed or passed with pain and difficulty; the pulse full, quick, and frequent; and the respiration laborious and painful: there is a sense of fulness and oppression at the heart with violent palpitation; intense headache, with giddiness, incessant restlessness, and severe cramps in the legs and arms, followed, if life is prolonged, by convulsions, tetanic spasms, epileptic fits, delirium, coma—a group of nervous symptoms varying with each case, and terminating in various ways, and at various intervals, in recovery or death.

In a second class, the symptoms are those of collapse. There is little or no pain, vomiting, or diarrhœa; a cold and clammy skin; extreme prostration of strength; very frequent and almost imperceptible pulse, or one as low as thirty or forty beats in the minute. The mind, as in most cases of arsenical poisoning, is unimpaired, but there is some approach to coma, slight cramps or convulsions, and death without reaction, usually in four or five hours, rarely beyond twenty hours. Sometimes this state of collapse is accompanied by constant vomiting and profuse purging.

In a third class of cases, the patient falls into a profound sleep, deepening into coma, and dies in a few hours without rallying. Such a case is recorded by Mr. T. Wright, of Dublin. Death took place in four hours, and followed upon sound sleep; and after death there was no trace of inflammation of the mucous membrane of the stomach even in the spots covered with arsenic.*

In a fourth class, the symptoms so closely resemble those of English cholera, as to avert suspicion from the minds even of in-

* 'Lancet,' vol. xii. p. 194.

telligent and well-informed physicians. Such was the case of the Duke of Praslin.

All these varieties occur under large and small doses of the poison; and they are not to be accounted for by the form or vehicle in which it is administered. The same dose administered in the same way may give rise to prolonged vomiting and purging in one man, to collapse in a second, to coma in a third, to violent irritative fever and severe nervous symptoms in a fourth; and these leading forms may even run into, and be blended with, each other.

Though these varieties do not admit of complete explanation, they become more intelligible when we reflect that the poison is an irritant to the alimentary canal, and, as such, gives rise to all the symptoms, local and remote, which follow such irritation—pain and tenderness, vomiting and purging, cramps and spasms; that it is absorbed into, and circulated with, the blood, developing in this manner its specific effects on the whole course of the alimentary mucous tract, and not only reinforcing the direct effect of the poison in causing pain and tenderness, vomiting and purging, but superadding redness and smarting of the conjunctiva, intense thirst, palpitation and rapid pulse; that it affects the nervous system both by its direct action on the parts with which it comes in contact, and by being circulated with the blood through the nervous centres, hence headache, delirium, convulsions, tetanic spasms, epileptic fits, extreme weakness, and paralysis; and that, lastly, it is in course of elimination from the system through the secretions of the liver, kidneys, and skin, giving rise in one person to jaundice, in another to dysuria (and even suppression of urine with its natural consequence, blood tainted with urea, and coma as a sequence), and in a third to painful cutaneous eruptions. Administered in large doses, or to feeble persons, the first shock to the system might prove fatal, as in drinking cold water or in blows on the stomach.

The great importance which attaches to poisoning by arsenic, and the variable character and grouping of the symptoms in different cases, renders desirable a more detailed account of symptoms and their combinations. The following summary, based on a careful analysis of a group of 25 cases, details the symptoms that were *stated* to be present.

Alimentary Canal.—Vomiting in 23 cases, but in one case not till artificially induced. (In a few cases, this, in common with every other marked symptom, has been wholly absent.) The *vomited matters* consisted, in 3 cases, of blood; in 2, of mucus tinged with blood; in 1, of mucus only; in 1, of water containing

arsenic; in 1, of bile, and in 1, of bile and fæces. (The vomited matters are sometimes described as yellow or brown.) *Diarrhœa* present in 11 cases, but absent in 4; in 7 of the cases excessive. The *matters passed by stool* consisted, in 3 cases of blood, and in 2 of a material closely resembling green paint. *Pain*, present in 19, and altogether absent in 1; in 2 instances it subsided after a short time, and it is stated not to have been increased by pressure in 2 instances. The *tongue and throat* sore, constricted, hot, painful, and tense, in 9 cases. *Thirst*: present in 15, and absent in 2; in 13, described as intense. The *countenance* flushed and swollen in 7 cases; pale and anxious in 5; the facies hippocratica present in 1. The *eyes* inflamed, swollen, or smarting in 7 cases. The *skin* hot and dry in 6 cases; covered with cold perspiration in 4; profusely perspiring, with petechiæ, in 3; universal desquamation in 1; covered with an eczematous eruption in 1. *Headache* in 9 cases, absent in 1; described as intense in 4. Violent *palpitation* in 2 cases. *Pulse* generally very frequent, but of variable character, ranging from 90 to 140, or more; in one case 30 to 49. Jaundice, suppression of urine, strangury, and salivation must be added to this list of symptoms. *Nervous Symptoms.*—Extreme *restlessness* in 5 cases; extreme *debility* in 10; *coma* in 3 cases; *delirium* in 3. The *mind* unimpaired in 6 cases; *cramps* in the legs in 9 cases, in 4 extending to the arms; *convulsions* in 6 cases; *paralysis* of tongue and gullet in 3 cases; *tetanus* in 2 cases; *chorea* in 1; *hysteria* in 1; *epilepsy* in 2. Tetanus, coma, and delirium successively in 2 cases. *Death* took place in 3 cases in the midst of convulsions, and in one after a horrible fit of convulsive laughter followed by rigid spasms of the whole body.

Locked jaw has been observed among the early symptoms—in one case so early as three quarters of an hour. (Orfila.)*

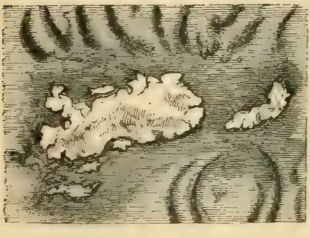
The long persistence of nervous symptoms is well illustrated by the case of Mr. Gadsden, one of the victims of Eliza Fenning. He was seized with epilepsy on the first day; had four attacks on the second, then a fit every evening at the same hour, for fourteen successive evenings; then an interval of seven or eight days, fol-

* The reader is referred to the following cases:—Messrs. Turner, and Mr. Gadsden, poisoned by Eliza Fenning, in Mr. Marshall's Remarks on Arsenic; those of the Mitchells, reported by Mr. Alexander Murray, in the 'Edin. Med. and Surg. Journal,' vol. xviii. p. 167, and three cases given by Mr. Alexander McLeod, in the same Journal, vol. xv. p. 553. These cases afford excellent illustrations of the nervous symptoms which follow poisoning by arsenic. Also 'Ed. Med. and Surg. Journal,' v. 389; liv. 106, 262; lvi. 295; lix. 250. 'Lancet,' July 21, 1827; Aug. 15, 1829; Oct. 31, 1829, vii. 254; Oct. 6, 1838; Nov. 3, 1838; and Nov. 24, 1838. 'Medical Gazette,' v. 411; ix. 895; xiv. 62; xv. 828; xix. 238; xx. 309. 'London Medical Review,' iv. 188; xix. 288. 'Guy's Hospital Reports,' No. iv. 68; and subsequent volumes.

lowed by another relapse, and that by another interval of three weeks; at the end of three months the fit still recurred every twelve hours, or three or four times in two days; and he continued, even after the lapse of two years, to be subject to frequent attacks. In the case of Helen Mitchell, there was extreme debility of the limbs for three months.

Post-mortem Appearances.—The stomach is the seat of acute inflammation, spreading over the entire surface, confined to the rugæ in well-defined patches, or streaks. Sometimes, in lieu of the bright tint of inflammation the membrane has the deep hue of congestion. When the poison is taken in substance, the most common and characteristic appearance is that of one or more patches, from the size of a shilling to that of a crown, consisting of a tough white or yellowish paste of arsenious acid mixed with coagulable lymph, firmly adherent to the inflamed mucous membrane, and forming so many centres of intense inflammation. White spots of arsenious acid are also often found between the rugæ. The annexed engraving shows a group of such spots resting on an inflamed base, and surrounded by deep dusky red streaks. Ulceration is comparatively rare, and perforation still less common. Gangrene also is a rare occurrence; but the dark swollen appearance produced by extravasation of blood into the sub-mucous tissue is often met with. The stomach usually contains a brown grumous matter, occasionally tinged with blood; but sometimes the colour is yellow, from the partial conversion of the poison into sulphide; and the mucous coat has been found smeared as with yellow paint. The inflammation generally extends to the duodenum and commencement of the other small intestines, and occasionally affects the whole length of the intestinal canal, being most conspicuous in the lower bowel. The œsophagus, also, is sometimes the seat of inflammation, and in rare instances the mouth, tongue, fauces, and windpipe have been involved in the inflammatory action. The peritoneal covering of the stomach or of the entire abdomen is sometimes found in a state of inflammation, and the intestinal glands are swollen. Among occasional post-mortem appearances may be mentioned, inflammation of the bladder, livid spots on the skin, and congestion of the brain with

Fig. 87.



serous effusion; but the most remarkable post-mortem appearance is the absence from the lining membrane of the stomach of all traces of inflammation, and of every other characteristic change. This anomaly is not due to death having taken place before inflammation could be set up; for well-marked inflammatory appearances have been present in the most rapidly-fatal cases.

It happens fortunately for the ends of justice that arsenic not only preserves the stomach when surrounding parts are in a state of advanced decay, but that even the characteristic appearances of inflammation may be present after several months of interment.

Fatal Dose.—In a solution, as small a quantity as *two grains* may prove fatal. *Two grains and a half,* contained in two ounces of fly-water, killed a strong healthy girl ætat. 19, in 36 hours (Letheby). Much smaller quantities have given rise to alarming symptoms. On the other hand, recovery has taken place from doses of half an ounce, an ounce, and even an ounce and a half, of the poison in substance. These larger doses are often taken on a full stomach, and are promptly rejected with the food, or carried away by the brisk action of the bowels.

Fatal Period.—The poison has proved fatal in *two hours,* in three or four instances (one by Mr. Foster, of Huntingdon, and one by Mr. Macaulay, of Leicester), but Mr. Thompson communicated to Dr. Taylor a case fatal with tetanic symptoms in *twenty minutes.* On the other hand, cases may prove fatal after three, four, five, six, or seven days, or even as late as the second or third week, and, from secondary symptoms, in two or three years. The average duration of fatal cases is 20 hours, of those which terminate within 24 hours, less than 7 hours. As many as 85 in the 100 die within 24 hours. More than half the cases terminate within 6 hours, two-thirds within 8 hours, and more than three-fourths within 12 hours.*

Mortality.—About half of the cases; fatal cases being to cases of recovery as 52 to 48.

Proportion of Suicidal, Homicidal, and Accidental Cases.—In 100 cases, about 46 are suicidal, 37 homicidal, and 8 accidental. This statement is based on 92 cases. The cases of suicide were equally divided between men and women.

Commencement of Symptoms.—In some instances, ten minutes

* Of 41 cases which survived less than a day, 3 were fatal in 2 hours; 1 in 2 hours and a half; 1 in 3; 2 in three hours and a half; 8 in 4; 6 in 5; 6 in 6; 2 in 6 hours and a half; 1 in 7; 2 in 8; 2 in 9; 2 in 12; 1 in 15; 1 in 17; 1 in 21, and 1 in 24 hours. Of 7 which lasted more than a day, 1 was fatal in 36, and 2 in 48, hours; 1 in 3 days and a half; 1 in 4 days and a half; 1 in 6, and 1 in 7, days.

after taking the poison; and they have been described as setting in immediately. But they may not make their appearance for several hours, and have been even delayed till ten hours. It is natural to suppose that sleep would delay the operation of the poison.

Treatment.—As arsenious acid itself is a powerful emetic, it sometimes excites such effectual vomiting that it is completely rejected from the stomach. This is most likely to happen when it is swallowed with, or soon after a meal. In other cases, on the exhibition of an emetic, or the abundant use of diluents, the contents of the stomach are rejected, and with them the poison. When, on the other hand, it is taken on an empty stomach, it attaches itself to the mucous coat, excites violent inflammation, and the formation of a tenacious secretion, which glues it to the surface, and protects it from the action both of emetics and antidotes. In the first class of cases recovery is often attributed to some substance which is thought to possess the virtues of an antidote. Arsenic, also, by its purgative action, may occasion so free an evacuation of the bowels as to carry off the poison partly by this channel.

The first step in the treatment consists in removing the poison as promptly as possible from the stomach. If the stomach-pump is at hand it should be used without delay. If not, and the poison itself is acting freely as an emetic, vomiting should be promoted by copious draughts of warm milk and water, and tickling the throat with a feather. If the patient is not sick, emetics of ipecacuanha, mustard, or common salt, aided by similar copious draughts of warm milk and water, should be given. When the stomach has been emptied by these means, milk, or milk beaten up with eggs, or a mixture of milk, lime water, and white of egg should be given freely at short intervals.

The rest of the treatment will be determined by the symptoms which happen to be most urgent. If the inflammatory symptoms run high, blood may be taken by leeches from the pit of the stomach. When coma threatens, blood may also be removed with advantage. The state of collapse must be met by stimulants, and the nervous symptoms by anodynes. Tetanic spasm would be best relieved by chloroform. The intense thirst may be satiated with small quantities of acidulated water; the tenesmus and dysuria by injections of gruel containing laudanum; the diarrhœa, if ineffectual and painful, by castor oil mixed with milk. Antimony must not be given as an emetic; for the resemblance of the crusts of antimony to those of arsenic would give rise to an objection to the chemical evidence. The sulphates of zinc and

copper, and antidotes containing iron ought also to be avoided, lest it should be alleged that arsenic existed in them as an impurity.

Antidotes.—Several preparations of iron, of which the hydrated sesquioxide is the best, the hydrated oxide of magnesia, calcined magnesia, and animal charcoal, have been recommended as antidotes applicable to arsenious acid in solution. The hydrated sesquioxide of iron, formed by precipitating the tinctura ferri muriatis of the shops with excess of ammonia, renders a solution of arsenious acid wholly or nearly inert, and some experiments on dogs made by Dr. W. Watt prove that, as an antidote for arsenious acid in solution, it is really efficient.* It should be freely given in the moist state. The hydrated oxide of magnesia precipitated from a strong solution of the sulphate by liq. potassæ, and well washed, has been also shown to be effectual, and is free from objection should the patient die, and an analysis of the contents of the stomach be required. When the poison is given in the solid form these reputed antidotes are quite useless.

While treating a case of poisoning by arsenious acid, or by other preparations of arsenic, it should be borne in mind that evidence of poisoning may be obtained by examining the urine, the serum from a blistered surface, or the blood, as well as from the matters vomited or passed from the bowels.

Arsenious acid has been introduced into the body otherwise than by the mouth. It has been inserted into the vagina, producing intense local inflammation, and the characteristic general symptoms of arsenical poisoning. It has been applied to the skin in the form of a mixed powder and of ointment, with similar local and constitutional results; and it has been inhaled as vapour, and as arseniuretted hydrogen. The smoke of candles containing arsenic has also produced severe indisposition.

OTHER PREPARATIONS OF ARSENIC.

Arsenite of Potash.—The active principle of Fowler's solution: in which it may be readily detected by any of the methods described for arsenious acid.

Arsenic Acid.—This acid, though a powerful poison, is of no medico-legal interest except as being formed in some processes for detecting arsenious acid. It is a white deliquescent solid, not completely volatilized by heat, very soluble in water, and having a strong acid reaction. It yields a metallic sublimate when reduced with charcoal, and a metallic crust when treated by Marsh's

* 'Wormley's Micro-Chemistry of Poisons,' p. 247.

or Reinsch's method; and gives a yellow precipitate with sulphuretted hydrogen, on boiling. It is precipitated a brown red by nitrate of silver, and by the ammonio-nitrate.

The salts of arsenic acid are called arsenates, and give the same reactions.

Arsenite of Copper (Scheele's Green).—This is a fine green powder, containing one part of arsenious acid to two of oxide of copper. It yields distinct crystals of arsenious acid when heated, and a residue of oxide of copper; and is soluble both in ammonia and in nitric acid.

Aceto-Arsenite of Copper.—This is a bright green powder known as mineral, Schweinfurt, Brunswick, or Vienna green, and in England as emerald green, or "emerald." It is largely used by paper-stainers, for fancy and for wall-papers, both alone to impart a full green colour, and mixed with oxide of zinc, porcelain powder, or whiting, to give more delicate tints of green. It has also been used to give a green colour to sweetmeats and confectionery, to wafers, to toys and cages, to cakes of water colour, to oil colours, to articles of dress, and to papers used as wrappers for fruits and sweetmeats.

Tests.—The powder consists of arsenious acid 6 parts; oxide of copper 2 parts; and acetic acid 1 part. Arsenious acid therefore constitutes two-thirds of its bulk. It is readily identified by giving off when heated strong fumes of acetic acid and depositing crystals of arsenious acid, with a residue of oxide of copper. In papers and other matters coloured with emerald green the poison is readily detected by scraping off the surface and subliming the powder thus detached: or, by dropping a fragment of the coloured material into a test-tube containing a weak solution of liquor ammoniæ. The material will be bleached; a blue solution will show the presence of copper; and if a fragment of nitrate of silver is dropped into it, a precipitate of the yellow arsenite of silver will be formed. If a paper stained with emerald green be touched with liq. ammoniæ, the spot and the liquid will turn blue.

Symptoms.—Those of the acute form of poisoning may be inferred from the case of a print-colourer admitted into King's College Hospital, June, 1858. Death was caused by an ounce of the poison in seven hours, under symptoms belonging to the second variety of arsenical poisoning described at p. 445. He did not vomit till an emetic was given, and diarrhœa did not form a prominent symptom. He was pale, excited, faint, and anxious, with a small feeble pulse, slight epigastric tenderness, intense thirst, profuse cold sweats, severe cramps in the calves of the legs, and in the hands, with twitchings of the legs and arms. The

patient never rallied, and died exhausted. The tongue was tinged green, and the matters rejected from the stomach and bowels were of the same colour. The stomach-pump was used, and the hydrated sesquioxide of iron freely given. The post-mortem appearances were a dirty green tongue; in the stomach a large quantity of the antidote speckled with green; congestion of its mucous coat, and of that of the small intestines; deep chocolate colour of the folds of the stomach, and dots of extravasated blood over the surface, especially near the pylorus. Lungs greatly congested; brain and kidneys sound.

It may be stated generally that the symptoms, post-mortem appearances, and treatment of poisoning by the arsenite of copper and by the aceto-arsenite, are those of poisoning by arsenious acid. In two cases the symptom of jaundice showed itself as if the copper had proved active.

Very severe, and even fatal, symptoms of irritant poisoning have been induced by eating substances coloured with arsenite of copper.

The symptoms of the chronic form of poisoning by inhaling and swallowing the powder detached from the walls of rooms have not been uniform. They have consisted of several of the following symptoms variously grouped:—The sneezing and lachrymation of a common cold; cough; nausea and loss of appetite, sickness and diarrhœa, colic pains, cramps, and spasms, dryness of the tongue and throat, and thirst; depression and weakness, headache, drowsiness, and extreme weakness, or actual palsy of the extremities. (In one case the dropped hand, as in poisoning by lead, in another great weakness and unsteadiness of all the limbs.)

When the powder is largely diffused through the air, as in chromo-printing, the consequences may show themselves in a quarter of an hour, or even less; and they commonly appear in one or two hours in the shape of severe catarrhal symptoms, with headache and bleeding at the nose, followed after a time by the rash presently to be described.

The persons employed in making artificial leaves, seeds, fruits, and flowers, chiefly young women, suffer from catarrhal symptoms and sore throat; the rash on the neck, face, ears, head, arms, and pudenda; thirst, nausea, anorexia, pain in the stomach, and vomiting, colic pains and cramp, palpitation and shortness of breath; great weakness, fever, headache, dimness of sight, drowsiness, restlessness, tremblings, and convulsive twitchings.

One fatal case, at least, has occurred among young women following this occupation. In the one fatal case with which my inquiries made me acquainted, the occupation had been carried on for

eighteen months, and she died in convulsions that had occurred every five minutes for seven hours and a half.

Arsenite of copper mixed with warm size is largely used in making tinted papers and paper-hangings, and is so laid on as to come into contact with the hands of the workmen. After one or two days the men begin to suffer, and are soon obliged to abandon their employment. The first symptom is a papular rash, running on to pustulation, about the root of the nostrils; the back of the ears, the bends of the elbow, and the inside of the thighs suffer in order; and then the scrotum, which I have often seen sprinkled with superficial circular ulcers from the size of a split pea to that of a fourpenny piece, looking as if cut by a punch. Sometimes the fingers are inflamed, and the nails drop off. The pulse is sometimes quickened, and occasionally the eyes smart and the epigastrium is tender. On abandoning the employment, the effects soon pass away; and they might certainly be avoided by scrupulous cleanliness and simple precautions to avoid contact with the poison.

Fig. 88.

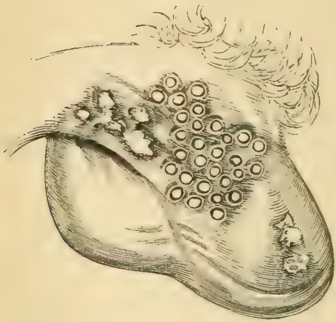


Fig. 89.

The effect of the poison on the scrotum is seen in fig. 88, which shows both the circular ulcers just described, and the diffused and ragged ulcerations figured by Dr. Vernois in the paper cited at p. 445. I have seen the circular ulcers more than

once. The ulcerations of the fingers are well shown in fig. 89, after an illustration by Vernois. The green powder is found adhering to their edges. Dr. Prosper de Pietra Santa, in the 'Annales d'Hygiène,' October, 1858, p. 339, gives a similar account of the effects of Schweinfurt green as used in Paris. See also an able paper by M. A. Chevallier in the same journal, July, 1859; a paper by Dr. Vernois in the 'Annales d'Hygiène,' year 1839, p. 316; and the author's report on 'Alleged Fatal Cases of Poisoning by Emerald Green, &c.,' in the 'Fifth Report of the Medical Officer of the Privy Council,' 1862.

The Arsenate and Binarsenate of Potash.—These are active poisons little used in this country. The arsenate is a white, deliquescent, and very soluble substance, with the reactions of "arsenic acid." The binarsenate is known as "Macquir's neutral arsenical salt."

The Arsenate of Soda is used as a medicine in France. A grain of the salt to an ounce of water constitutes "Pearson's solution;" and paper soaked in a solution of one part of arsenate of soda and two of sugar in twenty of water, is in use for poisoning flies. The "*papier moure*" owes its poisonous properties to arsenate of potash.

Sulphides of Arsenic.—Realgar, or red arsenic, and orpiment, or yellow arsenic, and King's yellow, which consists chiefly of orpiment, are used for tinting paper, and other similar purposes. Both orpiment and King's yellow contain arsenious acid, often in considerable quantities. The yellow sulphide of arsenic is the precipitate thrown down by sulphuretted hydrogen gas from liquids containing arsenious or arsenic acid, and their compounds. It is also occasionally taken as a poison; and is sometimes found adhering to the coats of the stomach after death, having been formed, as already stated, by the union of arsenious acid with nascent sulphuretted hydrogen, the product of decomposition. In organic mixtures the sulphides are detected by their characteristic colours. They are soluble in ammonia, and thrown down from the ammoniacal solution by muriatic acid.

The sulphides, when mixed with black flux and heated, yield metallic sublimates. (See p. 435.) When boiled with nitro-muriatic acid they are converted into arsenic and sulphuric acids.

The symptoms of poisoning by the sulphides are those of poisoning by arsenious acid; and the post-mortem appearances are also the same, with the exception that the contents of the alimentary canal have a yellow colour, and that the mucous

membrane is tinged of the same hue. The treatment is that of poisoning by arsenious acid.

Arseniuretted Hydrogen.—Several cases of poisoning by this gas, which is very rich in arsenic (each cubic inch containing little short of a grain of the metal), are on record. It has been more than once generated, instead of hydrogen, by sulphuric acid containing arsenic. A very interesting series of cases affecting a whole family, and due to the inhalation of the gas evolved from decomposing arsenite of copper, have been related by Dr. Elliotson. The symptoms were nausea, vomiting, thirst, watering of the eyes, red and foul tongue; a rapid pulse, ranging from 120 to 160, and, after apparent recovery, pains in the limbs. The patients derived much advantage from blood-letting. The poison seems to be eliminated by the kidney, in which organ it gives rise to severe irritation. In two instances cited by Christison, and in a third case by Vogel,* it occasioned hæmaturia.

Compound cases of poisoning by arsenic occasionally occur, that by arsenic and opium jointly being most frequent. The opium masks the characteristic action of the arsenic, so that the case resembles those rare instances of arsenical poisoning in which narcotic symptoms are very prominent. Such was the character of a case of poisoning by arsenic and laudanum which occurred some years since in King's College Hospital.

II. ANTIMONY AND ITS PREPARATIONS.

A few years since poisoning by antimony was so rare that the poison is not distinctly specified in the list of substances that proved fatal in the five years 1852–56. But since the trials of Palmer, Dove, McMullen, Hardman, Freeman, Smethurst, and Winslow, of which the first three took place in 1856 and the last in 1865, the subject of poisoning by antimony, and especially by small repeated doses of tartar emetic, has assumed great importance.

The preparations of antimony which are important in a medico-legal point of view, are tartar-emetic and the chloride. The precipitated sulphide is of interest from being developed in testing for the poison.

The *metal* antimony shares with arsenic the property of combining with nascent hydrogen, and of being deposited in the metallic form on burning the jet of gas, or heating the glass tube through which it is passing. It differs from arsenic in not being volatilized, when in the mass, by the heat of the spirit-lamp, and

* 'Brit. and For. Med.-Chir. Review,' Jan. 1854, p. 279.

with difficulty when in the form of thin films. In common with arsenic, mercury, and several other metals, it is deposited in the metallic form on copper when its solutions are treated after the method of Reinsch. The metal antimony often contains a minute fraction of arsenic.

The precipitated sulphide formed by transmitting a stream of sulphuretted hydrogen through a solution of a salt of antimony, or by treating metallic stains of antimony with sulphide of ammonium, is of a characteristic orange-red colour, and like the black prepared sulphide yields metallic antimony when heated in a current of hydrogen gas.

TARTAR EMETIC (*Tartarized Antimony, Stibiated Tartar, Potassio-Tartrate of Antimony.*)

This substance is found in the shops as a white powder, or as yellowish-white efflorescent crystals. In common with antimonial wine and James's powder, it may contain minute traces of arsenic, derived either from the metal antimony, or from the sulphuric acid used in its manufacture.

Properties.—Tartar emetic is soluble in about three parts of boiling and fifteen of cold water, but insoluble in alcohol; and it has a sickly metallic taste, and faint acid reaction.

Tests.—We may have to test for the poison in *substance*, in *solution*, in *organic mixtures*, and in the *fluids and tissues of the body*.

1. *In Substance.*

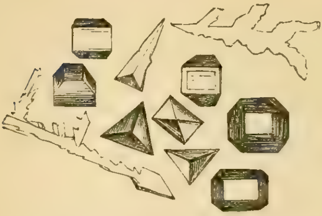
a. Heated by the flame of a spirit-lamp it decrepitates and chars, and if the heat is increased by the blowpipe, the metal is reduced. *b.* When heated in the manner described at p. 386, it is found to decrepitate at 380°, to sublime slowly and scantily (yielding an amorphous deposit on the glass disk) at 480°, and to char at 550°. *c.* When treated with sulphuretted hydrogen, or sulphide of ammonium, the characteristic orange-red sulphide is formed.

2. *In Solution.*

a. A drop of a solution of tartar emetic evaporated on a slip of glass leaves a crystalline deposit, which, when examined by lens or microscope, is found to contain well-formed crystals that are either tetrahedra (figs. 1 and 2, p. 391), or cubes with the edges removed (fig. 3), or some modification of the cube. Sometimes all the crystals assume the one shape, sometimes the other; but in many cases both kinds are to be found in the same specimen,

as in fig. 90; together with the branched crystalline forms so common in deposits from saline solutions. The best crystals are obtained from hot solutions.

Fig. 90.



b. The solution is proved to contain a salt of antimony by giving an orange-coloured precipitate with sulphuretted hydrogen, or sulphide of ammonium. This precipitate is soluble in caustic potash, in a large excess of ammonia, and in strong hydrochloric acid. The solution in hydrochloric acid has the characteristic property of letting fall a white precipitate when largely diluted with water. The sulphide is also decomposed when boiled in hydrochloric acid, sulphuretted hydrogen being given off, and chloride of antimony remaining in solution; and it may be reduced to the metallic state by heating it in a current of hydrogen gas.

c. The indication afforded by this test is confirmed by the following:—1. The three dilute mineral acids throw down a white precipitate, which is redissolved by the acid in excess, and by a solution of tartaric acid. Of these acids the nitric is least open to objection, but the three conjointly are conclusive. 2. A strong infusion of gall-nuts gives a dirty yellowish-white precipitate. 3. Ferrocyanide of potassium causes no precipitate.

d. Introduce a portion of the solution into a Marsh's apparatus, and proceed as in the case of arsenic (p. 436). The crusts obtained by inflaming the jet generally possess a less distinct metallic lustre and a more smoky appearance than those of arsenic, but crusts may be obtained which might be mistaken for those of the latter metal. The crusts in the horizontal tube have a characteristic shape (fig. 85, p. 439) and tin-like lustre. For the mode of distinguishing the crusts of the two metals, see p. 437.

e. Treat the solution after the method of Reinsch (p. 440), taking care to use copper free from antimony as well as arsenic. The antimony deposit is generally of a violet tint, and does not yield a crystalline sublimate. It may be dissolved off from the copper, either, 1, by boiling the metal in a weak solution of permanganate of potash rendered slightly alkaline by liquor potassæ (Odling); or, 2, by a weak solution of potash and the frequent exposure of the metal to the air (Mr. Watson, of Bolton). If the first process is adopted, the solution of antimony must be freed

from the brown deposit of the hydrated peroxide of manganese by filtration, then slightly acidulated with hydrochloric acid, and lastly, treated with sulphuretted hydrogen gas. If the second process is adopted, the solution of the metal is first filtered, then acidulated with hydrochloric acid, and lastly, treated with sulphuretted hydrogen.

f. The metal may be separated from liquids containing it by the process of electrolysis described at p. 441. It is deposited on the platinum plate connected with the negative pole of the battery, and may be identified either by washing it with sulphide of ammonium, and evaporating the solution, or by either of the methods just described.

3. *In Organic Liquids.*

All vegetable substances containing tannin decompose the salts of antimony, and milk is coagulated by their strong solutions. Several other vegetable substances affect the action of the tests. Coloured fluids, though they modify the action of the other tests, have little effect upon sulphuretted hydrogen, the sulphide retaining its characteristic colour. If no antidote has been given, and the poison has not been wholly rejected by vomiting, it may remain in the stomach unchanged. In this case we dilute, filter, acidulate with tartaric acid, transmit sulphuretted hydrogen gas through the liquid, and obtain the characteristic orange sulphide of antimony. If this process fails, we adopt for the solid contents of the stomach and the coats of the viscus the same method as for the organic tissues.

The discovery of antimony, by either method, in the contents of the stomach proves that one of its preparations has been taken, either as medicine, or as a poison; and if the quantity exceeds that of an ordinary medicinal dose, there is strong presumption of poisoning; but when the quantity is small, we cannot state that it has been administered as a poison, unless we can prove that it was not given as a medicine. Antimonial emetics are of course inadmissible in cases of poisoning.

4. *In the Tissues.*

Antimony is absorbed, and may be found in the secretions, blood, and solid viscera of the body. The process for detecting the poison in the blood or solid viscera is that already recommended for arsenic (p. 443). The resulting acid liquor may be treated after the method of Reinsch (p. 440), or that of Marsh (p. 436), or by electrolysis (p. 441). If by Reinsch's method the metal

must be identified in the manner just described: if by Marsh's method, by the characters described at p. 437.

Quantitative Analysis.—Use the precipitated sulphide, carefully washed and dried. One hundred parts corresponds to 20 of crystallized tartar emetic.

Experiments on Animals.

Large doses of tartar emetic, such as half an ounce, may b given to dogs with impunity if they are allowed to vomit; but few grains prove fatal when the gullet is tied. When injecte into the veins, it gives rise to vomiting and purging, and leave marks of acute inflammation in the alimentary canal and in th lungs. In some instances of speedy death there was no inflammation in any organ of the body.

An interesting series of experiments on slow poisoning by antimony has been made by Dr. Nevins ('Liverpool Medico Chirurgical Journal,' No. 1), in illustration of the death o M'Mullen, attributed to the repeated administration of smal doses of tartar emetic by his wife. The animals selected for experiment were rabbits, eleven in number, to which tartar emetic in powder was given four times a day, in doses of half a grain, a grain, and two grains. The quantity required to destroy life was twelve grains in a feeble rabbit, and seventy-two in the longest survivor. Five of the rabbits died, the first after four, the last after seventeen days. Three survived after taking the poison seventeen days; and three were killed, after one, three, and four days respectively, two after an interval of fourteen days, and one thirty-one days after taking the last dose.

The *symptoms* were *loss of appetite*, *loss of spirit*, and, after the sixth day, *great emaciation.* None of the rabbits *vomited*; and *diarrhœa* was absent in five out of eight. There were no *cramps;* but three of the five that died of the poison were violently *convulsed* a few minutes before death, and a fourth slightly so. Several of the animals had *ulceration of the mouth*, where the powder came in contact with the lining membrane. One of the rabbits, being with young, aborted.

The *post-mortem appearances* consisted in *congestion of the liver* in all the rabbits, *vivid redness* of some part of the lining membrane of the *stomach* in most, *ulceration* in two; and cartilaginous hardness of the pylorus in some. The *small intestines* in some of the animals presented patches of inflammation throughout, and, in two, the *solitary glands*, throughout the bowels, were enlarged, prominent, of a bright-yellow colour, and loaded with antimony. The colon and rectum were nearly always healthy.

in two instances the mucus of the stomach or bowels had a brownish colour, attributed to the formation of the sulphide. The *kidneys* were generally more or less congested, and the bladder vascular, and distended with urine. This was not the case, however, in the animals that were killed after a few days, or some time after the discontinuance of the poison. The *brain, heart,* and *spleen* were always healthy, but the *lungs* in many cases were deeply congested, and in some acutely inflamed, sometimes hepatized, and gorged with blood, the air-tubes being of a bright-red colour. Bloody extravasations (or exsudations) were found in the cavities of the chest and abdomen, and also between the muscular and mucous coats of the cæcum, in more than one instance.

The poison was found, by means of Reinsch's test, in every part of the body—*always* in great abundance in the *liver;* in smaller quantity in the *spleen;* at the earliest period in the tissues of the *stomach;* at a later period in the *kidneys*, and in the *cæcum*. The fæces always contained the poison—in one rabbit killed fourteen days, in another twenty-one days after the last dose. Antimony was also found in the *lungs* from an early period. In the *muscles* and in the *blood* it was difficult to detect; but it was found in the *bones* on the fifteenth day, and thirty-one days after the poison had been discontinued. It was also found in the fœtal rabbits, of which one of the poisoned animals aborted.

The poison was being constantly eliminated by the kidneys. It was discoverable in the urine after the twelfth dose: and in that voided twenty-one days after the poison had been suspended. This fact is in conformity with what has been already stated (p. 444), relative to the slow elimination of arsenic from the system. From these experiments Dr. Nevins infers—"that tartar emetic is a deadly poison when repeated in small doses for a sufficient length of time; but that the total quantity necessary for causing death, and also the length of time required, are very variable in different cases; that there is a considerable general similarity in the symptoms and morbid appearances produced, but by no means absolute uniformity; that the poison permeates almost all the tissues of the body, and even those of the unborn offspring, if its administration is continued long enough, whilst, at the same time, it is constantly being eliminated from the system by the kidneys and bowels; and lastly, that the fatal effects are often disproportionate to the apparent changes found after death."

These conclusions are generally in harmony with the results of the experiments of Messrs. Millon and Lavran, made in 1846. ('Annales d'Hygiène,' vol. xxxvi. p. 221.)

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms of acute poisoning in the huma subject are:—A strong metallic taste perceived in the act c swallowing, with heat, constriction, and soreness of the mouth an throat, followed by nausea, vomiting, pain and tenderness of th epigastrium, extending to the whole abdomen, soon followed b repeated and profuse diarrhœa, with severe cramps of the ex tremities, and symptoms of collapse:—cold skin, clammy sweat a small quick pulse, and great weakness. Death may happen i this state of collapse; but it is sometimes preceded by deliriun convulsions, and tetanic spasms. Large doses sometimes occasio insensibility as one of their earliest effects. In more than on instance the characteristic pustular rash has been present on th skin and in the throat. In some exceptional cases there has bee no vomiting and no purging till other emetics were administere

Fatal Dose.—In an adult, two grains; in a child, $\frac{3}{4}$ of a grai (Taylor, 'Guy's Hospital Reports,' Oct. 1857.) One drachm tartar emetic killed a healthy adult in ten hours. A grain and half given with fifteen grains of ipecacuanha two days runnin caused vomiting, purging, prostration, and death in a health woman five days after her confinement. ('Med. Times and Gaz. March 28, 1857.) Children have been killed by ten grains in few hours. On the other hand, such large doses as ℥j have bee frequently swallowed with impunity, in consequence of its prom rejection from the stomach, or recovery has taken place witho early spontaneous vomiting, but with profuse diarrhœa, after tl occurrence of very dangerous symptoms.* Very severe effec have been produced by so small a dose as six grains. It has ofte been given in inflammation of the lungs, in doses of two grain repeated at short intervals, without producing any injurious effect

Fatal Period.—Tartar emetic, in a single large dose, may ki in a few hours (in an adult female, quantity unknown, in 7 hou —Wormley); but, on the other hand, a patient survived near five days the taking of forty grains, and a scruple of the poiso proved fatal to a woman after a year of suffering.

Mortality.—Somewhat less than half the cases.

Tartar emetic applied externally in lotion or ointment caus inflammation of the skin and a crop of pustules, and, if continue may produce sloughing. Nausea and vomiting have sometim attended this external use of the poison.

Post-mortem Appearances.—Inflammation of the mucous me

* See a case by Dr. Gleaves: 'Wormley's Micro-Chemistry of Poison p. 217.

brane of the stomach extending sometimes to the small intestines; rarely to the throat and gullet. Sometimes inflammation in the lungs, and in the brain. After death by repeated small doses, special attention should be paid to the state of the cæcum and large intestines. See *ante* for the appearances in animals, and for the appearances in the human body in one case where antimony was found, and believed to have been repeatedly administered, see 'Observations on the Medical Evidence in the Case of The Queen *v.* Smethurst.' By T. G. Geoghegan, M.D., 'Dublin Med. Press,' 1859.

Treatment.—The best antidote is tincture of cinchona bark. When this is not at hand, the decoction or powder may be substituted, or liquids containing tannin, such as strong tea, or decoction of oak bark. In the absence of the antidote, or while it is being prepared, vomiting should be promoted by warm water, milk, or mucilaginous drinks, and by tickling the throat with a feather; or the stomach-pump may be employed. The after-treatment must be determined by the symptoms. General or local blood-letting may be necessary, and opium may be prescribed with advantage.

Chronic Poisoning.—The experiments of Dr. Nevins already detailed have removed any doubt which may have attached to recent medico-legal cases, as to the power of tartar emetic, in repeated small doses, to destroy life. It gives rise to nausea, vomiting, and purging, extreme debility, and fatal exhaustion; and the like symptoms have occurred in man.* In infants and young children, especially when suffering from diseases such as croup, there seems to be great tolerance of tartar emetic, as is proved by several cases related or quoted by Dr. Elliotson, in which tetanic symptoms were present as in some cases of poisoning in the adult. ('Med. Times and Gazette,' July 5, 1856.)

Chloride of Antimony (Butter of Antimony).

A corrosive liquid, of a light-yellow or dark-red colour, which has been taken by mistake for ginger-beer, and for antimonial wine. When largely diluted with water the white oxychloride of antimony falls down, and the clear liquid is proved to contain muriatic acid by the addition of nitrate of silver. The subsidence of a white precipitate on adding water in excess is common to this liquid and solutions of the salts of bismuth; but with sulphuretted hydrogen gas bismuth yields a black, and antimony an orange-red, precipitate.

* See Dr. Geoghegan's paper just quoted.

Symptoms.—The action of the chloride is both prompt and violent. In one fatal case, death took place in ten hours and a half after swallowing between two and three ounces of the liquid. Narcotic symptoms were added to those of violent irritation of the alimentary canal, and after death the mucous membrane of the entire canal presented a charred appearance, and was softened and abraded. Recovery has taken place after swallowing an ounce of the poison.

Treatment.—That of poisoning by tartar emetic. Large draughts of warm water should be promptly administered, followed by tincture of bark.

III. MERCURY AND ITS PREPARATIONS.

These are in common use in the arts and in medicine, and they are occasionally used as poisons. They take the seventh place among the ascertained causes of death by poison, coming next after oxalic acid, and they are credited by the Registrar-General with ten deaths a year, on the average of the five years 1852–6. Corrosive sublimate, the preparation usually taken or given as a poison, was the cause of twelve out of 543 deaths from poison in 1837 and 1838; of which twelve cases two were accidental, and nine suicidal. Metallic mercury, as used in the arts, gives rise to severe and well-defined maladies, and the medicinal preparations of mercury occasionally prove fatal when given in an overdose, or in an ordinary dose to persons very susceptible to their action. The metal itself is inert, and may be given in large quantities without injury; but its oxide when diffused through the air, or brought into constant contact with the skin, is well known to produce injurious effects.

One important property of metallic mercury requires to be noticed, as it is made use of in medico-legal inquiries. It sublimes unchanged at 660°, and when the sublimation is conducted in a glass tube, a ring of small metallic globules is deposited. In a more minute state of division it has the appearance of a black powder; and is thrown down in this form from the solutions of its salts.

The most important preparations of mercury are:—the chloride or corrosive sublimate; the sub-chloride, or calomel; the ammonio-chloride, or white precipitate; the red oxide, nitric oxide, or red precipitate; the sulphide, cinnabar, or vermilion; the sub-sulphate of the oxide, or Turpeth mineral; the bicyanide, or prussiate; and the two nitrates. The black sub-oxide, and sub-sulphide are less important.

Of these, corrosive sublimate is by far the most important.

CORROSIVE SUBLIMATE (*Oxymuriate, Corrosive Muriate, Bichloride,* more properly *Chloride, of Mercury*).

This preparation is used for preserving the feathers of birds and skins of animals from moth; for destroying bugs and killing lice and maggots in man and in animals; and when dissolved in spirits of sweet nitre as a favourite remedy for gonorrhœa and syphilis.

Properties.—A very heavy crystalline mass, or white powder, of a peculiarly nauseous taste, permanent in air, but slowly decomposed in sunshine, an insoluble grey powder being formed. It is soluble in twenty parts of cold, and two of boiling, water. It is more soluble in alcohol and ether, for which reason ether is used to remove it from its aqueous solutions. Common salt, also, increases its solubility.

Tests.—We may have to search for the poison in *substance,* in *solution,* in *organic liquids,* and in the *tissues and organs of the body.*

1. *In Substance.*

When heated on platinum foil it is wholly dissipated in white acrid fumes. Heated on a porcelain slab with the flame of a spirit-lamp, it sublimes at 200° Fahr., and melts at a higher temperature. The sublimate received on a superimposed disk of glass consists of small groups of plates mostly drawn to a point at one or both ends, and often radiating two, three, or more from a point. Fig. 91 shows a coarse, and fig. 92 a more delicate

Fig. 91.

Fig. 92.

× 60.

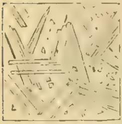
specimen, the last from a photograph. The arrangement shown in fig. 93 is less common in sublimates than in deposits from liquids. If a sublimate does not happen to be characteristic, a minute drop of liquor potassæ applied to one part of it, and of solution of iodide of potassium to another, will identify it by the yellow and scarlet reactions. As arsenious acid treated in the same way yields octahedra, and calomel an amorphous deposit, this test

is almost conclusive. The great solubility of corrosive sublimate in water further distinguishes it from arsenious acid and calomel. The addition of a few drops of liquor potassæ places the nature of the substance beyond a doubt. It turns yellow, while arsenic undergoes no change, and calomel is blackened. We may obtain still further assurance by the following tests: 1. Sulphide of ammonium blackens the powder. 2. A solution of iodide of potassium turns it to a bright scarlet. 3. Moisten a clean rag with dilute hydrochloric acid, sprinkle the powder upon it, and rub it on a clean plate of copper: it produces a silvery stain readily volatilized by heat. 4. Mix one part of the poison with four parts of calcined bicarbonate of soda; place the mixture in a dry reduction-tube (fig. 44, p. 383), or in the short tube (fig. 45, p. 383), and cautiously apply the heat of a spirit-lamp: a ring of globules will be formed on the cool sides of the tube, or on the glass disk placed over its mouth.

2. *In Solution.*

a. On the supposition that we are ignorant of the contents of a liquid submitted to analysis, we may ascertain that it contains a crystalline salt by evaporating a drop of the liquid on a glass slide, and examining the dry spot under the microscope. Corrosive sublimate is deposited, in long single needles, plates branched or stellate, as in figures 91, 92, or in parallel groups of needles or plates, as in fig. 93. *b.* Or we test for a base by sulphuretted hydrogen, which yields with corrosive sublimate a black precipitate, first giving a milky appearance to the liquid. *c.* Sulphide of ammonium also gives a black precipitate. *d.* With liquor ammoniæ it yields, in common with lead and bismuth, a white precipitate, but with liquor potassæ a yellow (the hydrated oxide). By this we recognise a per-salt of mercury. The supernatant liquor contains chloride of potassium, and if we add to it nitrate of silver we obtain the white chloride, which proves that the salt of mercury is a chloride. *e.* This yellow precipitate being collected, washed, and dried, and heated in a reduction-tube, gives a well-defined ring of mercury. The sulphide precipitated by sulphuretted hydrogen, or by sulphide of ammonium, when dried and heated with bicarbonate of soda, also yields a ring of mercury.

Fig. 93.



Additional tests: 1. Protochloride of tin. A solution of this substance throws down a white precipitate, turning rapidly to grey, and from grey to black. The black deposit is minutely divided mercury. The supernatant liquor being decanted or separated by filtration,

and the deposit dried, the globules coalesce. 2. Metallic test. Acidulate the liquid with a few drops of hydrochloric acid, and introduce a narrow slip of clean copper. A grey film will be formed on its surface. This being carefully dried, placed in a reduction-tube, and heated by the spirit-lamp, yields a ring of metallic globules. Pure tin, zinc, or silver may be substituted for copper; but the latter is to be preferred. 3. Galvanic test. Take a narrow strip of zinc foil, and coat it with gold leaf; drop this into the solution slightly acidulated with hydrochloric acid; the gold will soon be covered with a grey film. Remove it from the solution, dry it carefully, introduce it into a reduction-tube, and heat it. A ring of metallic globules will be formed. This test is very delicate, and applicable to very minute quantities. The metallic deposit may be readily obtained by placing a drop of the acidulated solution on a surface of clean copper or gold, and touching the moistened metal with a fragment of zinc or iron. Wollaston once employed, in court, a key and a sovereign for this purpose.

Mercury is one of the metals deposited on copper when its solutions are treated after the method of Reinsch (p. 440). The deposit is known as mercurial by drying the copper, and heating it in a reduction-tube, when a ring of metallic mercury will be formed.

The acid in combination may be shown to be the hydrochloric by testing the fluid from which the mercury has, by any of the foregoing methods, been precipitated, with nitrate of silver, which yields a white precipitate of chloride of silver.

3. *In Organic Liquids.*

Corrosive sublimate is sometimes swallowed in substance, or imperfectly dissolved; and though very soluble, may be found in the stomach in a solid form, and may be separated by diluting the viscid contents with distilled water, stirring them, allowing the heavy corrosive sublimate to subside, and quickly pouring off the supernatant liquor. More commonly the poison is given dissolved in water or in some liquid suited to disguise its taste; and, when so given, may be decomposed by the contents of the stomach, or by the mucous membrane itself. The poison may, therefore, exist in the stomach partly in solution undecomposed, partly in combination with its contents, partly in union with its coats.

If any of the poison exists in the free state, it may be readily separated by diluting the contents of the stomach with distilled water, obtaining a clear liquid by filtration, shaking it in a stoppered bottle with an equal bulk of ether, and drawing off the

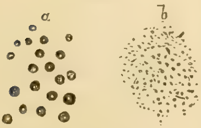
ethereal solution with the pipette. By evaporating a drop of the solution on a glass slide, the crystals depicted in fig. 93 will remain. They may be tested directly by minute drops of the reagents already described.

The solid contents of the stomach may be examined by the same method as for the organic tissues.

4. *In the Organic Tissues.*

Bring the organic matters into a state to pass the filter by the method described at p. 443; and test the liquid by the method of Reinsch (p. 440). If the copper receives a grey coating, wash it in distilled water, dry it, and heat it in a reduction-tube (fig. 48, p. 384). Globules of metallic mercury will be deposited on the cool side of the tube, or on the glass disk (fig. 45, p. 383). When, as in examining the tissues, we have to deal with small quantities of mercury, we should employ the form of reduction-tube figured at p. 384. This test is a very delicate one. The five-thousandth of a grain can be readily sublimed and identified. The appearance of a group of globules obtained from this small quantity of the metal is shown in *a*, fig. 94, where they are magnified 70 diameters and measure $\frac{1}{200}$ inch. Sometimes the metal is oxidized, and then presents the appearances depicted in *b*, fig. 94. Among spots of no very defined shape are found a number of prismatic crystals, some scarcely longer than their breadth, while others are long needles.

Fig. 94.



As arsenic deposited on copper by Reinsch's process, and sublimed in the same way, may also yield distinct globules, it will be necessary to distinguish the one from the other. The globules of arsenic have a strong metallic lustre, and might easily be mistaken for the more liquid drops of mercury, though they have not quite so smooth a surface (fig. 73, p. 427).

It would evidently be unsafe to rely on this slight difference, but happily the distinction is rendered easy by the fact that the globules of arsenic obtained in this way are always mixed with the characteristic octahedral crystals of arsenious acid, while those of mercury are either unmixed, or blended with the small needles just described and figured. The arsenical sublimate, when obtained in the presence of atmospheric air, either consists wholly of crystals, or of globules and crystals, the globules occupying the part of the tube nearest the flame of the lamp, and the crystals the part more remote.

When a liquid found in the stomach, or obtained by simple boiling, yields mercury by any of the processes now described, we have evidence of a soluble salt of mercury, and a strong presumption in favour of corrosive sublimate; but when the solid matters after evaporation to dryness are treated with hydrochloric acid, we have no evidence of a soluble salt, because even an insoluble salt, thus treated, would be converted into corrosive sublimate. This process, then, is open to the objection that the mercury which it is the means of discovering may have been administered as a medicine in the form of calomel, blue pill, or grey powder. This objection could only be answered by distinct evidence of such substances not having been given as medicine, or by the characteristic symptoms and post-mortem appearances due to corrosive sublimate being present.

Corrosive sublimate, like arsenic and other active poisons, may be rejected from the stomach so as not to be detected after death.

Quantitative Analysis.—Though the presence of mercury may be ascertained by the methods already described, the quantity of the poison is best determined by means of the protochloride of tin. When the poison is in solution, the protochloride of tin should be added so long as any precipitate falls. The precipitate should then be washed, dried, and weighed.

When there is reason to believe that the quantity of corrosive sublimate is considerable, we may follow with advantage the summary process recommended by Christison. The solid matters are to be triturated with protochloride of tin; when the mixture will assume a slate-grey colour, and separate readily into a liquid and coagulum. The liquid may be rejected, but the coagulum, having been washed on a filter, must be carefully removed and boiled in a moderately strong solution of caustic potash, until all the lumps disappear. The oxide of tin with the animal and vegetable matters are thus dissolved, and the solution, on remaining at rest, deposits a heavy grey powder, consisting chiefly of finely divided mercury. To separate the mercury completely, the solution must be allowed to remain at rest, at a temperature little short of boiling, for about twenty minutes. The supernatant liquor may then be drawn off, and the remaining black powder, after repeated washings, may be removed, heated, and sublimed. This process is very delicate. Of the metallic mercury thrown down by the protochloride of tin, 100 grains correspond to $135\frac{1}{2}$ of corrosive sublimate.

Experiments on Animals.

The experiments of Sir Benjamin Brodie show that corrosive

sublimate is a very active poison. Six grains dissolved in six drachms of water killed a rabbit in $4\frac{1}{2}$ minutes, and a scruple proved fatal to a cat in 25 minutes. The rabbit became insensible in three minutes, and was convulsed; and on opening the chest the heart had ceased to beat, and its left cavities contained scarlet blood. The mucous membrane at the cardiac end of the stomach was of a dark-grey colour, much softened and readily detached; but similar effects were produced by the poison after death. Sir B. Brodie attributed its fatal effects to this chemical action. Dr. Bostock and other experimenters, by giving smaller doses, produced the common symptoms of irritant poisoning, followed by death after some hours; and on dissection the mucous membrane of the stomach was found inflamed.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Immediately, or within one or two minutes of swallowing a substance or liquid of a peculiarly nauseous, metallic, styptic taste, there is a sense of tightness and burning in the throat and gullet, greatly increased by pressure, and by attempts to swallow, speedily followed by burning pain in the epigastrium, also increased by pressure. Vomiting and purging of stringy mucus or of bilious matter often containing blood ensue, and the entire abdomen becomes distended and exquisitely painful. The face is generally flushed and swollen and the eyes sparkling; but in other cases the countenance is pale and anxious, the lips white and shrivelled, and the eyes dull but expressive of great anxiety. The diarrhœa is accompanied with tenesmus, and dysuria is often present, the secretion of urine being scanty or altogether suppressed. The pulse is full, quick, and frequent, or small, frequent, and intermittent, according as the symptoms are those of high fever or of collapse, and the breathing is quick and catching. There are sometimes drowsy intervals of comparative ease, and this drowsiness sometimes deepens into coma. Nervous symptoms, consisting of cramps, twitches, and convulsions of the limbs, are often present from an early period; and occasionally there is paralysis. Death takes place during a faint, in the midst of strong convulsions, or during protracted insensibility. To these symptoms, in most cases which do not prove rapidly fatal, salivation is superadded, and the painful train of nervous symptoms caused by the specific effect of mercury on the system.

But the symptoms are by no means uniform, nor is the mode of death always the same. Three varieties of cases at least may be recognised:—1. Violent irritation of the stomach and bowels, with collapse. 2. Salivation and other remote effects, with little

or no irritation of the alimentary canal. 3. Irritation of the stomach and bowels, followed by salivation and remote constitutional effects.

Mercurial Salivation.—A brassy taste, a peculiar fetor of the breath, tenderness and swelling of the mouth, inflammation, swelling, and ulceration of the gums, and an increased flow of saliva, are the familiar symptoms of mercurial salivation. In the worst cases salivation is profuse; the face, neck, and tongue swollen; the inside of the mouth ulcerated or gangrenous. These local affections are preceded or accompanied by a quick pulse and hot skin, and other symptoms of fever.

Several interesting questions suggest themselves in connexion with this symptom of mercurial poisoning:—*a.* What is the smallest dose which will occasion salivation? *b.* Can salivation be produced by other causes, and if so, can we distinguish it from the effects of mercury? *c.* What is the earliest period at which salivation may occur? *d.* How long may it last? *e.* Can salivation cease and recur without a renewed use of the mercurial preparation? *f.* Is it possible to distinguish gangrene of the mouth, the effect of mercury, from the same disease due to other causes?

a. Smallest dose. There is much difference between individuals, between persons of different ages, and even in the same person at different times, in respect of the quantity of mercury which can be borne. As a general rule, children are less susceptible of the action of mercury than adults, the robust than the delicate. The same female who in her ordinary state of health is affected with difficulty, shall, when suffering from anæmia, be salivated with a few doses of blue pill. In affections of the nervous system, also, very marked effects are often produced by small doses of mercury.* Again, there are many persons peculiarly susceptible of the action of mercury, and others whom the largest doses continued for a long time will not affect. Many instances of severe, and even fatal, effects produced by small doses are on record. In an apoplectic patient of Dr. Bright's five grains of calomel placed on the tongue produced in three hours violent salivation, and such swelling of the tongue as to render scarifications necessary. Three grains of corrosive sublimate in three doses have caused violent ptyalism: three five-grain doses of blue pill, given one every night, have proved fatal; two grains of

* In a case of paralysis of the facial nerve which came under my notice, there was a distinct red line upon the gums of the paralysed side, while the other was quite free. The sensibility of the affected side was perfect, though the patient complained of tingling.

calomel have caused ulceration of the throat, exfoliation of the jaw, and death; and the external application of three drachms of mercurial ointment has destroyed life in eight days. (Christison 'On Poisons.')

b. Salivation from other causes. Salivation may occur spontaneously, so as to constitute a disease in itself, or it may be due to the mere accumulation of saliva, in consequence of some disease of the throat, such as quinsey, preventing deglutition. It may even be occasioned by the influence of the imagination, as in a case related by Christison. Various preparations of gold, copper, lead, arsenic, antimony, and bismuth; sulphuric acid, iodine, and iodide of potassium; several vegetable substances, such as castor-oil, fox-glove, opium, and prussic acid, have also given rise to salivation.

The distinction between mercurial salivation and that dependent upon other causes is generally easy, in the first stage. Mercurial salivation is preceded by the coppery taste and fetor of the breath, and accompanied by redness, sponginess, and ulceration of the gums. These are wanting in spontaneous salivation, and in that produced by most of the medicines just mentioned.* But the advanced stage of mercurial salivation seems to differ less strikingly from some severe affections of the mouth due to other causes, and accompanied by ptyalism. Thus in a curious account of an epidemic salivation, forming part of a tertian fever, quoted from Haller's Collections on the authority of Quelmelz, it is stated that in one instance it was as great as the most violent mercurial salivation, and was accompanied by fetor, superficial ulceration of the mouth, pustules on the tongue, relaxation of the gums, and looseness of the teeth. (Christison.)

c. Earliest period. Mercurial salivation rarely sets in under twenty-four hours; but in Dr. Bright's case already cited, it appeared in three hours. In a case of poisoning by two drachms of corrosive sublimate, it began in four hours. (Taylor.) The shortest period, therefore, may probably be stated at three hours.

d. Duration. This is very variable, and may be very considerable. It may continue for any period from a few days to as many years. In one instance it is alleged to have lasted six years. ('Lancet,' No. 453.)

e. Intermittent salivation. Dr. Robert Williams ('Elements

* A case under my care when the last edition of this work was in the press seems to justify the cautious statement in the text. All the symptoms of severe mercurial salivation were present as the effect of a course of iodide of potassium, in the ascertained absence of mercurial preparations, other than those given from time to time as aperients, such aperients not having previously affected the system.

of Medicine,' vol. ii. p. 523) gives a case on the authority of Dr. Daniel, in which salivation was suspended for eight or nine days under an attack of remittent fever, and then returned, though no mercury had been given after the fever came on. Instances of recurrence of salivation after three and even four months are on record; but in one case at least, quoted by Christison, the recurrent salivation was unattended by fetor, redness, ulceration, or sponginess of the gums. The possibility of recurrent mercurial salivation is also confirmed by analogy; for in the case referred to in the foot-note to page 472, the salivation is proved to have taken place after the iodide of potassium had been suspended for several weeks.

f. Gangrene of the mouth. Cases of *cancrum oris* following debilitating diseases, or occurring in children badly lodged and badly fed, are not of very rare occurrence. In such cases it very seldom happens that mercury in some form has not been given. Hence, a difficult question may arise as to the cause of the disease. In the absence of any exact means of discrimination, it may be sufficient to state that extreme debility, brought on by any of the causes just mentioned, is a sufficient cause; and that even if the mercury which may have been given has contributed to the fatal result, the medical man is not to be blamed for the use of a medicine of great value in the diseases of children, and which less frequently causes salivation in them than in adults. It is generally stated that gangrene, the effect of mercury, may be distinguished by its beginning in the mucous membrane of the mouth and throat, while the cancrum oris begins in the skin of the cheek or chin. This statement is without foundation; for in a fatal case of mercurial salivation that occurred under the care of Dr. John Bright, of the Westminster Hospital, the gangrene began as a small black spot between the lower lip and chin. Other cases of the same kind are on record.

Mercurial Tremors, Shaking Palsy, Tremblement Métallique.—This disease occurs in men whose work exposes them to the fumes of mercury, or causes them to handle the oxide so as to absorb it by the skin; such as quicksilver miners, water gilders, mirror silverers, and barometer makers. It sometimes begins suddenly, sometimes comes on gradually; and may or may not be attended by salivation. The upper extremities are commonly first affected, and then, by degrees, all the muscles of the body. In the worst cases, the patient can neither speak, masticate, nor walk. The unsteadiness of the arms prevents him from grasping any object, and the muscles of the legs are so convulsed that he cannot plant his foot firmly on the ground, but when he tries to

walk, his gait becomes an unsteady dancing trot. If the patient does not give up his work, he loses his memory, is unable to sleep, becomes delirious, and so dies. On leaving off his work he generally gets well, but the recovery may occupy some weeks or months. Sometimes the disease is incurable. The absorption of the poison is sometimes indicated by a blue mark on the gums, as in lead poisoning, but more commonly by a dark red line; and a curious symptom not generally recognised, though very commonly present, is a brittle state of the teeth, causing them to chip. The preventive treatment of this affection consists in cleanliness and ventilation; and the swallowing of white of egg in water three or four times a day may be recommended.

In two instances, an exposure of some days' duration to the vapours of mercuric methyl in course of preparation in the laboratory of a medical school, gave rise to cerebral symptoms, ending after prolonged suffering in utter annihilation of intellect.

Post-mortem Appearances.—Corrosive sublimate and the soluble salts of mercury give rise to post-mortem appearances intermediate between those produced by the corrosive acid poisons and by the stronger non-corrosive irritants, such as arsenic. Corrosion, softening, and sloughing ulceration of the stomach and intestines are of frequent occurrence, and the peritoneum is often inflamed. The sloughs have been found to yield mercury on analysis. Sometimes the small intestines escape, and the poison acts only on the stomach and on the rectum, or on the large intestines generally. The decomposition of the salt by contact with the mucous membrane, with the contents of the stomach, or with antidotes, and the consequent deposition of minutely divided mercury on the lining membrane, as a thin slate-coloured covering, sometimes serves to identify the poison. When the body is in a state of decay, a similar appearance of the mucous membrane may be caused by the action of sulphuretted hydrogen, giving rise to the formation of the black sulphide. When mercurial salivation has existed during life, we find the mucous membrane of the mouth inflamed or sloughing.

One post-mortem appearance which has been more frequently encountered in poisoning with corrosive sublimate than in poisoning with arsenic, is the highly inflamed state of the urinary organs, and the contraction of the bladder, corresponding to the scanty secretion of urine during life.

Intense inflammation and ulceration, and even sloughing of the cæcum and large intestines, is also a marked occurrence in poisoning by corrosive sublimate—more common than in poisoning by tartar emetic and arsenic. These appearances, in the case

of a poison so liable to decomposition by the contents and tissues of the alimentary canal, is probably due to the elimination of the poison by the solitary glands.

Corrosive sublimate applied to the mucous membrane after death hardens it, and causes it to assume a dead white, wrinkled, and granulated appearance, with rose-coloured vessels ramifying upon it. These appearances extend to the muscular and peritoneal coats. Sir B. Brodie found the same effect to be produced on the living and dead mucous membrane.

Fatal Dose.—*Three* grains have proved fatal to a child. Very large doses have been swallowed with impunity, having been rejected by vomiting, or decomposed by the prompt use of antidotes.

Fatal Period.—The shortest period on record, *half an hour*, was in a case reported by Mr. Welch to Dr. Taylor. Cases of death in two or three hours are not rare. The nitrate of mercury has proved fatal in two hours and a half. In the case of this poison, as in that of arsenic, the period is extremely variable.*

Mortality.—More than half the cases.

Treatment.—The best antidote to corrosive sublimate is albumen. Gluten, or wheat flour, milk, iron filings, a mixture of gold dust and iron filings suspended in gum water, the hydrated protosulphide of iron, the carbonates of the alkalies, and meconic acid, have also been suggested. Those most readily procured are the white of egg and gluten. The white of egg should be given freely mixed with water, as long as urgent symptoms are present, accompanied, if necessary, by emetics and diluents. If eggs cannot be procured, flour mixed with water, or milk, may be substituted. White of egg has been proved to be an efficient andidote in so many cases, that where it is at hand it is unnecessary to resort to any other.

The rest of the treatment is that proper to poisoning by the irritants generally. Where salivation is present, cool air, cold drinks, and gentle aperients, with gargles of alum or common salt, must be used. Acetate of lead, recommended in ordinary medical treatment, would be objectionable in medico-legal cases.

* The following periods are on record :—one of 2 hours; one of $2\frac{1}{2}$ hours; one of 3 hours; one of 6 hours; one of 11 hours; and one of 3, 6, 8, and 11 days respectively. Of these nine cases, then, about half the number died in less than 12 hours, and the remaining half in a period varying from 3 to 11 days.

The reader is referred to the following cases :—'Medical Gazette,' vii. 329; viii. 616; xxix. 797; xxxi. 556. 'Ed. Med. and Surg. Journal' (five cases by Mr. Valentine), xiv. 468; li. 114; liii. 404; lviii. 505.

Occasionally, when the inflammatory symptoms run high, local or general blood-letting may be resorted to.

Corrosive sublimate acts as an irritant, and produces its characteristic effects in whatever way it may be introduced into the system.

CALOMEL (*Subchloride of Mercury, Protochloride of Mercury*).

Properties.—A heavy white or yellowish-white powder, insoluble in water, alcohol, and ether, but soluble in nitric and hydrochloric acids.

Tests.—On the supposition that we are ignorant of the nature of the powder, we first test it by heat. Like corrosive sublimate and arsenic, it volatilizes, but as an amorphous powder, and at a temperature of 240° Fahr. Its insolubility in water distinguishes it from corrosive sublimate, but not from arsenious acid. It is turned black by sulphide of ammonium, liquor potassæ, and liquor ammoniæ. It reacts like corrosive sublimate with protochloride of tin: heated with carbonate of soda, it yields a sublimate of metallic mercury, and it gives a silvery stain when moistened with dilute muriatic acid and rubbed on copper foil.

Calomel, though generally a safe medicine, and one that may be given in many diseases in large doses often repeated, sometimes acts as a strong irritant poison, or destroys life by producing gangrene of the mouth and throat. Cases are on record of fatal results following a single dose of a scruple, and quantities so small as fifteen, eight, and six grains. On the other hand, doses of three drachms, and of one ounce have been taken with impunity. In the Asiatic cholera, and in the severe fevers of hot climates, calomel in repeated doses of one scruple has appeared to be beneficial.

These exceptional effects of calomel have been attributed to its partial conversion into corrosive sublimate by the free hydrochloric acid of the stomach, or by contact with chloride of sodium or muriate of ammonia. The quantity of corrosive sublimate formed by either of these reactions has been shown to be extremely small. A minute quantity of corrosive sublimate, such as the 500th of its weight, is sometimes found mixed with calomel.

The other compounds and preparations of mercury possess poisonous properties; but as they are very rarely taken as poisons, a brief description of them will suffice.

Red Precipitate (red oxide of mercury).—This, mixed with lard or grease, is largely used for destroying vermin. Its crystals are small, brilliant, and of a scarlet or deep orange colour; the powder is orange coloured. It is very heavy, insoluble in water,

but soluble in warm hydrochloric acid, which converts it into corrosive sublimate. Heated in a reduction-tube it is entirely dissipated, metallic globules are sublimed, and oxygen gas given off.

Cinnabar, Vermilion (bisulphide of mercury).—This is found in commerce as a dark red semi-crystalline mass, or as a fine red powder. The former is cinnabar, the latter vermilion. When thrown down from a solution of a per-salt of mercury by sulphuretted hydrogen, it is black; but, when sublimed, becomes red. It is heavy, insoluble in water and muriatic acid, entirely dissipated by heat, but collects on the sides of the tube unchanged. When mixed with carbonate of soda, and heated in a reduction-tube, globules of mercury are sublimed; and on adding a mineral acid to the residue, sulphuretted hydrogen is given off, showing the presence of sulphur.

White Precipitate (ammonio-chloride of mercury).—A white heavy powder, insoluble in water, and entirely dissipated by heat. It yields with carbonate of soda a metallic sublimate. On boiling the powder with liquor potassæ, ammonia is given off, chloride of potassium is formed, which may be detected by the nitrate of silver and bichloride of platinum test, and the yellow peroxide of mercury remains.

Turpeth Mineral (sulphate of the oxide of mercury).—A heavy yellow powder, sparingly soluble in water, and yielding, when heated, a metallic sublimate, with fumes of sulphurous acid gas. When boiled in a solution of potash, the yellow peroxide is thrown down, and a sulphate of potash formed, which may be identified as above.

Nitrates of Mercury (nitrate and subnitrate).—The nitrate of mercury is in the form of white crystals, very soluble in water, and yielding a highly acid and corrosive solution. When heated, the crystals give off nitrous acid gas, and yield metallic globules. Mixed with carbonate of soda and heated, the metal is sublimed. On adding liquor potassæ to a solution of the salt, a yellow precipitate is thrown down. The acid is readily detected by adding carbonate of potash till effervescence ceases. Nitrate of potash remains in solution.

The subnitrate differs from the nitrate in yielding with liquor potassæ a *black* precipitate.

Bicyanide of Mercury (prussiate of mercury).—This consists of white, heavy, inodorous crystals, which have a strong metallic taste, are soluble in hot and cold water, but nearly insoluble in alcohol. When heated, the crystals yield metallic mercury and cyanogen gas, recognised by the characteristic purple colour of its flame. When heated with hydrochloric acid, hydrocyanic acid is

given off. The solution yields with sulphuretted hydrogen, and sulphide of ammonium, a black precipitate, but it gives no precipitate with liquor potassæ.

All the foregoing preparations of mercury have, in rare instances, been taken as poisons. Their activity is proportioned to their solubility. Thus the soluble nitrates and the bicyanide, even in small doses, are extremely active poisons, while the white and red precipitate, turpeth mineral, and vermilion act much less powerfully. The soluble salts act as corrosives, the insoluble compounds as irritants. Either may produce the specific effects of mercury. In poisoning by the bicyanide, the symptoms are those of poisoning by a soluble salt of mercury. The cyanogen, in combination with the mercury, not seeming to modify the action in any marked degree.

Two cases of poisoning by red precipitate occurred in the practice of Mr. A. Prince, and are reported in the 'Medical Times and Gazette,' November, 1859. In one of them, the symptoms of acute irritant poisoning were followed on the third day, (the dose being two drachms,) by violent salivation, with extensive destruction of the soft parts.

IV. LEAD AND ITS PREPARATIONS.

Acute poisoning with the salts of lead is rare. One case only (by Goulard's extract) occurred in the two years 1837-8; and though no less than twenty-three deaths from the "salts of lead" are returned by the Registrar-General for the average of the five years 1852-56, it is obvious that they were chronic cases, for no case of lead poisoning occurs in the lists of suicides, murders, and manslaughters. From the great use made of lead in the arts, its effects as a slow poison are familiar to every medical man.

The metal itself is not poisonous; but as it is readily acted on by acids, it may impart poisonous properties to such liquids as wine, cyder, and vinegar, when used (as formerly in Devonshire) in making or repairing the presses. It may become poisonous by combining with the contents of the stomach.

The preparations of lead which are used in medicine or the arts, are the two oxides, the carbonate, the acetate and subacetate, the sulphate, the chloride, and the nitrate. Of these, the carbonate and the acetate are the most important in a medico-legal point of view.

Tests.—On the supposition that we are ignorant of the base contained in a solution presented for analysis, we first transmit sulphuretted hydrogen through it, or add a few drops of the sulphide of ammonium. Lead is one of those bases which give with

this reagent a black or deep brown precipitate; and liquor ammoniæ, liquor potassæ, and dilute sulphuric acid throw down a white precipitate. By this succession of trial tests, we infer that the solution contains a salt of lead.

The base is completely identified by the following tests: 1. Chromate of potash throws down a gamboge-yellow chromate of lead. 2. Iodide of potassium yields an iodide of lead of the same colour. 3. If a fragment of zinc the size of a pin's point be placed in a drop of the solution, the lead is deposited in one of the annexed forms. The lead tree is developed very rapidly, and should be examined under the microscope before it has become obscured by the white carbonate. This test acts characteristically on one grain of the acetate of lead in four ounces of distilled water.

Fig. 95.

Oxides of Lead.—There are three oxides of lead: the protoxide, red lead, and the peroxide. The protoxide, as a yellow semi-crystalline glass, is the *litharge* of commerce; as a fine powder, it is *massicot.* A combination of the protoxide and peroxide is the minium, or red lead, of commerce. The brown peroxide is little known out of the laboratory.

Litharge (protoxide of lead).—This is in common use by painters and glaziers, and forms a cheap glaze for the common kinds of earthenware. Serious accidents have arisen from this glaze being acted upon by acids. Litharge has also been used to impart a sweet taste to sour wines. As already stated (p. 5) it is a constituent of the hair dyes in common use. It consists of reddish or yellowish scales, which are volatile at a red heat, insoluble in water, but perfectly soluble, when pure, in nitric acid, the solution possessing the properties of nitrate of lead, and the base giving the reactions already described. It is readily reduced on charcoal by the heat of the blow-pipe.

Minium, or Red Lead.—This is the colouring matter of red wafers; and has been found mixed with snuff. It is a rich red powder, insoluble in water, and but partially dissolved by nitric acid. When heated, it gives off oxygen, and is reduced to the orange-yellow protoxide. It is readily reduced under the blow-pipe; and on burning the wafers which contain it, small globules of lead form on the edges, mixed with the unreduced yellow protoxide.

White Lead (ceruse, carbonate of lead).—This is largely used in the arts, chiefly as the basis of colours, and for enamel cards, and becomes the common cause of colica pictonum and of other forms of chronic poisoning by lead. It is sold in white masses, or as a heavy white powder, and has the following properties:—When heated to redness, it loses its carbonic acid, and is changed to the yellow protoxide. It is insoluble in water, but soluble with effervescence in nitric acid. In large doses it may act as a poison, though very insoluble in water. It is, however, largely dissolved in water containing free carbonic acid.

Sugar of Lead (acetate of lead).—This substance is sold as a crystalline mass resembling lump sugar, or as a glistening, heavy, white powder. It is very soluble in water, has a slight odour of vinegar, and a sweetish astringent taste. When heated, it dissolves in its water of crystallization, gives off part of its acid, chars, and is partly reduced to the metallic state. When heated in the mouth of a glass tube under the blowpipe, distinct globules of lead are formed. If boiled with dilute sulphuric acid, acetic acid is given off, which may be known by its odour. The powder is also blackened by sulphide of ammonium, and changed to a fine yellow by iodide of potassium and chromate of potash. In solutions, it gives the characteristic reactions of all the soluble salts of lead.

Goulard's Extract (subacetate of lead).—This is a yellowish-white alkaline solution, distinguished from a solution of the acetate by the copious precipitate of carbonate of lead, formed by transmitting a stream of carbonic acid gas through it. It is an active poison, and has more than once proved fatal.

Sulphate of Lead.—This is a heavy white powder, insoluble in water and in acids, unchanged by heat, and blackened by the sulphide of ammonium. If suspended in water, and sulphuretted hydrogen gas transmitted through it, the black sulphide of lead is formed, the sulphuric acid remaining in the supernatant liquor, as shown by the nitrate of baryta test. This salt of lead, being extremely insoluble, is stated not to be poisonous; but if given in a very large dose might not be quite inactive.

Chloride of Lead.—A white powder, sparingly soluble in cold, but more soluble in hot water, soluble in dilute nitric acid, but insoluble in alcohol. It has a sweetish taste. At a heat below redness, it fuses into a semi-transparent horny mass (*plumbum corneum*), but is volatilized by an intense heat. Its solutions have the reactions of a salt of lead.

There is a yellow oxychloride of lead used as a pigment under the name of *mineral*, or *patent yellow*, and *Turner's yellow.*

Like the chloride, it is fusible, and remains fixed when melted.

Nitrate of Lead.—This is a crystalline salt, soluble in water. It is largely used in calico-printing, and forms the basis of Ledoyen's disinfecting fluid. When heated in a glass tube, nitrous acid vapour is given off, and the yellow protoxide remains behind. The solution gives the characteristic reactions of a salt of lead; and filtering paper dipped in it and dried, burns like touch paper.

Salts of Lead in Organic Liquids.—Add to the suspected liquid a little nitric acid; boil, and filter. Transmit sulphuretted hydrogen gas through the filtered liquid. If a salt of lead be present, a black precipitate will be formed. If no precipitate falls when the liquid is thus treated, collect the solid matters remaining on the filter, incinerate, dissolve the ash in nitric acid, dilute, and filter the resulting liquid, and transmit the sulphuretted hydrogen gas as before.

If by either or both of these processes a black precipitate is obtained, it may be proved to contain lead in two ways:—1. By placing the dried precipitate on a fragment of charcoal, and reducing the metal by the blowpipe. Or, 2, By exposing the sulphide to a red heat in a tube of German glass open at both ends, to burn off the sulphur, treating the residue with strong nitric acid, and diluting the resulting solution with distilled water. The solution must then be filtered, evaporated to dryness, and gently heated to expel the excess of acid. The residue, being dissolved in distilled water, will give the characteristic reactions of lead.

If no lead should be obtained by either of the foregoing methods, the stomach itself may be cut into fragments and incinerated.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—All the salts of lead, with the exception, perhaps, of the sulphate, act as weak irritant poisons, differing from other irritants chiefly in the absence of diarrhœa, and the presence of the opposite state—constipation. Even the most soluble preparations act more feebly than most of the metallic irritants, and rarely prove fatal.

The usual symptoms caused by a large dose of a soluble salt of lead are a burning and pricking pain in the throat and gullet; thirst; vomiting; colic pains with tenderness of the belly, and obstinate constipation; cramps, cold sweats, and, in fatal cases, convulsions, and tetanic spasms. In one case the pulse fell to 40.

The most important and interesting form of lead poisoning is

that which is brought on by the long-continued use of preparations of lead, as medicine, in the arts, or in consequence of the accidental impregnation of water, beverages, or articles of food. The effects of the poison first show themselves as the painters' colic; more remotely as the lead palsy.

The Painters' Colic, called also after Poictou, the district where (in modern times) it was first observed, *Colica Pictonum*, is marked by excruciating pain of the abdomen, especially in the pit of the stomach and around the navel, almost always relieved by pressure. The belly is hard, the muscles of the abdomen strongly contracted, and the navel drawn inwards. The bowels are either obstinately confined, or scanty motions are passed with much suffering. Very rarely diarrhœa is present. The urine is scanty, and passed with difficulty. The countenance is dull and anxious, the skin bedewed with cold perspiration, the pulse commonly of the natural frequency, but sometimes accelerated, the breathing quick and catching. In rare instances febrile symptoms are present.

The painters' colic sometimes comes on without previous symptoms of disease, at others after long-continued indigestion and disorder of the bowels. It may terminate either in complete recovery, or may pass into the second form of chronic poisoning —lead palsy. In rare instances it terminates in a species of apoplexy, which comes on with giddiness, extreme weakness, and torpor. As these symptoms increase, the pains in the belly subside, and the patient at length dies convulsed and comatose.

Lead Palsy.—This is sometimes the termination of a single attack of colic, but more commonly it supervenes after repeated seizures. In some cases, again, it comes on without any previous attack of colic. The disease chiefly affects the upper extremities, especially the muscles of the hand and forearm, which first lose their power and then gradually waste away. The loss of power is chiefly in the extensor muscles, so that when the arm is raised, the hand falls by its own weight. Hence the expression, "dropped hand." The patient characteristically raises one hand by the aid of the opposite arm.

This affection is difficult of cure, and very apt to recur on the renewed application of its cause. The persons most subject to it are those employed at furnaces for smelting lead ore, manufacturers of litharge, and of red and white lead, house-painters, colour-makers, plumbers, and workers in lead, glass-blowers, glaziers, potters, and manufacturers of glazed cards. It occurs occasionally in persons who make comparatively little use of lead, as in compositors from the handling of the types, in fishmongers

from the use of lead counters covered with brine.* In other cases, it is traced to the use of drinking water contained in leaden pipes or cisterns, under the circumstances presently to be mentioned. This is a not uncommon cause of lead poisoning in animals.

In the course of the several employments just mentioned, lead finds its way into the system either by the skin, the lungs, or the stomach.

The chief practical rule for the prevention of disease consists in the strict enforcement of cleanliness. A great amount of disease has been prevented by the substitution of moist for dry grinding.

A blue line on the gums round the margin of the teeth affords a valuable indication of lead poisoning. It is rarely absent where marked symptoms of poisoning are present, and it exists in many cases in which it is not possible to prove the introduction of lead into the system, and when we are driven to attribute it to tainted drinking water.

Post-mortem Appearances.—In a case of acute poisoning by Goulard's extract, the lower end of the gullet, the whole stomach and duodenum, part of the jejunum, and the ascending and transverse colon were greatly inflamed, and the villous coat of the stomach appeared as if macerated. The stomach contained six ounces of a reddish-brown fluid which had a sweetish, styptic, metallic taste, exhaled the odour of vinegar while evaporating, and yielded globules of lead when the dry residue was subjected to the process of reduction. (Christison.)

In colica pictonum there are no constant morbid appearances beyond an unusual constriction of the large intestines. In lead palsy the affected muscles are found pale and flaccid, and when the disease has been of long continuance they resemble white fibrous tissue.

Treatment.—The antidotes to the salts of lead are the soluble alkaline or earthy sulphates, of which the sulphate of magnesia is to be preferred. These should be freely administered, dissolved, or suspended in water. If vomiting is absent, it may be excited by emetics of sulphate of zinc, and encouraged by copious draughts of warm water; or the stomach-pump may be used. Milk and white of eggs may be given with advantage. When the pains are severe, and the bowels costive, opium may be given in combination with aperients, and copious injections of warm water afford relief. The rest of the treatment is that proper to the irritant poisons.

In consequence of the extensive use of lead in pipes and

* I have witnessed two or three cases among this class of tradesmen.

cisterns for conveying and holding water, and the ill effects which may result from the action of the water upon it, it is important to examine the circumstances under which that action takes place. This subject has been carefully investigated by Drs. Christison, Taylor, and Miller. The principal results of their inquiries may be briefly stated as follows:—

The contact of air and water with the metal leads to the formation of an oxide which is dissolved in the water. The solution absorbs carbonic acid from the air, and the resulting oxycarbonate is deposited in silky scales. A fresh portion of oxide is formed and dissolved, and a fresh crop of crystals deposited; and in this way the metal is rapidly corroded. The free access of air is essential to these changes, for distilled water deprived of its gases by boiling, and excluded from the air, has no action on lead. The action of air and water on lead is very rapid when the water is pure. Thus distilled water, or very soft water, or rain water collected in the open country, left in contact with pure lead, with the free access of air, causes a very rapid corrosion of the metal; but the rain water collected from the roofs of houses in large towns, in consequence of the impurities which it dissolves, has little or no action on lead.

On the other hand, the action of water on lead is greatly modified by the presence of saline substances, even in the small quantity of three or four grains to the gallon. The chlorides and nitrates promote corrosion; but the sulphates, phosphates, and carbonates obviate it. Bicarbonate of lime is a very effectual preservative; and to its presence many springs owe their property of not acting on lead. Sulphate of lime, in so small a quantity as one part in 5000, also affords complete protection. Some kinds of river water, as that of the Thames, contain sufficient saline matter to render the use of lead perfectly safe. The same remark applies to most spring waters. But the waters of some rivers and springs are so destitute of saline matters as to act powerfully on lead. It must, however, never be forgotten that carbonic acid, if present in the water, will completely counteract the preservative effect of the salts above mentioned. It is better, therefore, to forego the use of lead for cisterns and water-pipes. Slate should be used for cisterns, and iron, earthenware, or glass for pipes.

It may be stated, then, as a general result, that the action of water on lead, and the consequent danger of conveying and preserving it in pipes or cisterns made of that material, varies directly as the purity of the water. It follows that we may render the use of lead for such purposes perfectly safe by the

artificial admixture of saline matter with the purer kinds of water. Sulphuric acid, by forming an insoluble sulphate of lead, is also an efficient protection. The use of lead is attended with most danger when it is employed to collect or preserve rain or snow-water, or spring water of unusual purity; and the danger is increased by the use of leaden lids to cisterns, the pure water rising by a natural process of distillation, and collecting on the lid.

There is another cause which greatly facilitates the action of water on lead, and may neutralize the preservative effects of saline matter, and be even intensified by its presence—namely, the galvanic action excited by the contact of some other metal, or metallic solder, with the lead.

Vegetable acids and fatty substances have the property of dissolving lead; hence the danger of keeping ascescent fruits, or liquors, or fatty matter, in vessels made of that material, or glazed with the oxide. Sour milk, cider, wine, and rum have acquired poisonous properties in this way. Shot used for cleaning wine-bottles, and carelessly left in them, have impregnated the wine with lead.

For the elimination of lead from the system it is usual to prescribe iodide of potassium in doses of five or ten grains three times a day.

V. COPPER AND ITS PREPARATIONS.

Poisoning with the salts of copper is very rare. Among the 543 cases of poisoning in England and Wales in 1837–8, not one was due to this cause, nor is the poison specified in the Registrar-General's list of the causes of violent death in the five years 1852–56. In consequence of the marked colour of all the salts of copper, they are not likely to be taken accidentally, and they are ill adapted to the purposes of the murderer. They are, however, occasionally taken by the suicide. The use of copper utensils in cookery sometimes leads to the accidental admixture of poisonous salts of copper with food; and the sulphate of copper has been improperly employed to promote the fermentation of dough, to decolorize sugar, and to give a green colour to pickles. The arsenite or aceto-arsenite of copper is also largely used in the arts. See Arsenic (p. 452).

Metallic copper is not poisonous, but as it readily oxidizes and combines with acids, it cannot be swallowed with impunity. Very injurious consequences have accordingly been produced by sucking copper coin; and when minutely divided and used in printing processes, it appears to act as a poison.

Copper in the form of oxide, and in union with acids, is in

common use in the arts. The hydrated peroxide, the carbonate, the sulphate, and the acetates, must be briefly noticed.

The Hydrated Peroxide.—This is met with under the two forms of mineral green and verditer. Mineral green formerly consisted of arsenite of copper, but is now formed by a combination of the hydrated peroxide with pure lime or chalk, potash, and alumina. Verditer consists of the same materials in a different proportion.

The anhydrous peroxide of copper is a brownish black powder, which is readily dissolved by nitric acid, the solution assuming, on the addition of ammonia in excess, a deep blue colour. The *hydrated* peroxide of copper may be procured by adding liquor potassæ to a solution of any of the soluble salts of the metal.

As none of the salts of copper assume the importance of arsenious acid or corrosive sublimate, it will suffice to consider the tests for copper generally, and then to describe and distinguish from each other those salts which are in common use.

Tests.—The salts of copper are distinguished from most other substances by being either blue or green. Sulphate of iron and the salts of nickel are also green, and will, therefore, have to be distinguished from the green salts of copper. In very dilute solutions the colour of the salts of copper disappears, or is so masked as to afford no clue to the nature of the substance with which we have to deal. On the supposition that we have no clue to the contents of the solution, we first test the liquid with sulphuretted hydrogen, which occasions a deep brown or black precipitate. Sulphide of ammonium yields the same precipitate. On adding liquor ammoniæ to the solution, the hydrated peroxide is first thrown down, but is redissolved on the addition of ammonia in excess, the resulting liquid having the characteristic deep blue colour of the hydrated peroxide.

The salts of copper in solution may be further identified by the following tests:—1. Ferrocyanide of potassium yields a fine hair-brown gelatinous precipitate; 2. Polished iron (a needle suspended by a thread) placed in the solution is soon coated with a thin film of the metal; 3. A drop of the solution placed on platinum foil, slightly acidulated, and touched with a strip of zinc, yields the same metallic deposit; 4. If a minute fragment of zinc is placed in a drop of a solution of a salt of copper on a flat surface of glass, the copper is deposited in an arborescent form; and distinguished by its colour.

Some of the salts of copper may have to be distinguished from each other.

Carbonate of Copper (natural verdigris).—This is the greenish

coating formed on the surface of copper and its alloys by the action of air and water. It is readily distinguished by effervescing with acids. The reactions of the base are those of other salts of copper.

Sulphate of Copper (blue vitriol, blue-stone, Roman vitriol).—The base may be detected by the tests already described. By adding a few drops of liquor ammoniæ, and a solution of arsenious acid, green arsenite of copper is thrown down. The acid in combination is shown to be sulphuric by the nitric acid and nitrate of baryta test.

Subacetate of Copper (artificial verdigris).—The term artificial verdigris is applied either to the unmixed subacetate, or to a combination of this with the neutral acetate and carbonate. Its colour accordingly varies, being sometimes blue and sometimes green. The subacetate is known by the effect of heat. When heated in a test-tube by the flame of a spirit-lamp part of the acetic acid is given off; and the remainder being decomposed, supplies carbon to deoxidize the copper; so that a film of metal is left on the side of the tube. Acetic acid is also disengaged when the salt is boiled with dilute sulphuric acid.

Nitrate of Copper.—This consists of deliquescent blue crystals. The acid in combination may be detected by the absence of a precipitate with nitrate of baryta, and with nitrate of silver; and by the ruddy fumes of nitrous acid gas evolved on boiling the crystals with tin filings in a few drops of distilled water. By adding liquor potassæ to the solution, nitrate of potash is formed, which may be identified by appropriate tests (p. 403).

Chloride of Copper.—There is a bright green, soluble, deliquescent chloride, and a white insoluble subchloride of copper. An oxychloride is known as Brunswick Green.

The tests for the base are the same as for other salts of copper. The hydrochloric acid in combination may be detected, in the case of the soluble chloride, by the addition of nitrate of silver. The insoluble subchloride must be converted into a soluble salt for the purposes of examination.

Arsenite of Copper.—See the chapter on Arsenic (p. 452).

Copper in Organic Liquids.—Solutions of copper are decomposed by several of the common contents of the stomach—such as albumen, fibrin, milk, tea, coffee, &c., and by the mucous membrane of the stomach, the suboxide being thrown down. As the salt of copper is not always completely decomposed, it may often be obtained in sufficient quantity for analysis by boiling with distilled water and passing the solution through a filter. The insoluble substances must be reserved for further examina-

tion. By slightly acidulating the liquid, and then passing through it a stream of sulphuretted hydrogen, the brownish-black sulphide of copper is thrown down. This must be collected, washed, and dried; and incinerated in a glass tube, so as to free it from adherent organic matter. The sulphide may now be converted into sulphate by treating it with a few drops of nitric acid. The solution will strike the usual deep blue colour with an excess of ammonia.

If copper is not by this means detected in the liquid which has passed the filter, the insoluble substances which remain on the filter, or are contained in the stomach, must be dried and heated to redness in a crucible, till they are completely charred. The residue contains metallic copper, and must be gently heated in equal parts of nitric acid and water. Nitrate of copper is thus formed, which may be identified by the usual tests.

Copper has been detected in the solid organs of the body, but more rarely in the secretions, in cases of poisoning by its salts. But it has been asserted to be a normal constituent of the animal frame.

Copper has also been found in several vegetable substances used as food, and M. Boutigny has traced it to the manure used in raising those substances. Its presence as a natural constituent of the human body, has, however, been rendered doubtful by the negative results of experiments performed by Christison and Chevreul. As the quantity of copper existing naturally in animal and vegetable substances does not exceed in any case one part in 120,000, and is in some instances so little as one part in 1,500,000, it can give rise to no fallacy even where large portions of the solid contents of the stomach or of the body itself are submitted to analysis.

Quantitative Analysis.—Use for this purpose the precipitated sulphide, digest it in nitric acid, and precipitate the oxide from the solution by potash. One hundred parts of the black oxide correspond to 312 of crystallized sulphate.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms set in from a quarter to half an hour after swallowing the poison, with pains in the abdomen resembling colic, nausea, eructations, vomiting of matters of a bluish or green colour, purging and cramps. Nervous symptoms, such as convulsions, palsy, tetanus, and insensibility, have been present in different cases. As in poisoning by arsenic and mercury, the symptoms are variously grouped in different cases. One symptom

of frequent occurrence in poisoning with the salts of copper is jaundice.

Post-mortem Appearances.—The mucous membrane of the stomach and intestines has been found inflamed, ulcerated, thickened, and of a green colour, and in parts apparently gangrenous. The salt of copper sometimes adheres to the surface of the membrane. The inflammation and discoloration occasionally extend to the gullet. The intestines have been found perforated. The skin is yellow. The other post-mortem appearances are not characteristic.

Treatment.—The antidotes to the salts of copper are albumen, and iron filings. The first is to be preferred. The treatment will consist in the free administration of the white of egg, followed by mucilaginous drinks. If vomiting is not present the stomach-pump may be used. The rest of the treatment will vary with the symptoms.

Fatal Dose.—In a case mentioned by Dr. Percival, convulsions were occasioned by two drachms of blue vitriol.

Fatal Period.—The salts of copper have proved speedily fatal. A girl aged sixteen months died in *four* hours after swallowing several fragments of blue stone (Taylor). In other instances death has taken place after long intervals, such as 12, 13, 60, 72, and 78 hours.

Accidental Poisoning by Copper.—Serious and even fatal accidents have occurred from the use of copper vessels in cooking. The inmates of a monastery suffered severely from obstinate and severe colic, retching, and bilious vomiting, costiveness, flatulence, burning pain in the pit of the stomach, in the kidneys and extremities, and paralytic weakness in the arms. Gmelin traced these symptoms to the fact, "that every vessel in the kitchen, the pots and pans, and even the milk pails and butter dishes for storing the butter, were made of copper."

The principal facts established in reference to the impregnation of various fluids and articles of food with copper, in consequence of being prepared or kept in copper vessels, are the following :—Distilled water kept in contact with clean copper is not impregnated with it. Solutions of several saline matters, as common salt, alum, nitre, and Epsom salts, when heated in copper vessels, are found to contain the poison. Acids, and fatty and oily matters, especially when rancid, act still more strongly upon them. One general principle applies to all these substances—namely, that they may be boiled in clean vessels with comparative safety, but cannot be allowed to stand in them without danger. The contact of air with the moistened copper leads to the formation of the

hydrated carbonate, which is dissolved by any acid that the substance may happen to contain. As copper vessels cannot be safely used in cooking without precautions that are apt to be neglected, it would be well to let them fall into disuse.

VI. ZINC, TIN, SILVER, IRON, BISMUTH, CHROME, AND THEIR PREPARATIONS.

ZINC.—Two preparations of zinc require notice—the sulphate and chloride.

Sulphate of Zinc, White Vitriol, White Copperas.—This substance is in common use as an emetic, but is unimportant as a poison. It is found in the form of colourless, or nearly colourless, prismatic crystals, very soluble in water, and of a styptic taste. It resembles oxalic acid and sulphate of magnesia. From the former it is distinguished by tests, for which see oxalic acid ; and from the latter by the addition of sulphuretted hydrogen or sulphide of ammonium. The sulphate of zinc yields a white precipitate, but the sulphate of magnesia none.

Sulphate of zinc in solution possesses the following properties :— 1. It is precipitated as a white sulphide by sulphuretted hydrogen and sulphide of ammonium, provided the solution does not contain an excess of acid. 2. Liquor ammoniæ and the sesquicarbonate throw down a white precipitate soluble in an excess of the precipitant. 3. Ferrocyanide of potassium causes a white precipitate.

If the sulphate of zinc contains iron, the precipitates will not be a pure white.

In Organic Liquids.—Sulphate of zinc is decomposed by albumen and milk, which form with the oxide an insoluble compound ; and also by substances containing tannin. The first step of the process consists in acidulating with acetic acid, which dissolves any oxide that may be thrown down in union with animal matters. The mixture must then be filtered, and sulphide of ammonium added. A white sulphide is thrown down, which must be washed, collected, dried, and heated to redness in a glass tube. The residue is then to be acted on by strong nitric acid, which dissolves the zinc; and the acid solution, being neutralized by carbonate of ammonia, is ready for the application of the tests. The carbonate of zinc which results from this decomposition becomes yellow when heated, and white again on cooling. It is redissolved by excess of the precipitant.

Symptoms.—Sulphate of zinc has a disagreeable bitter taste, and causes, in large doses, dryness of the throat, thirst, vomiting, purging, and pain of the abdomen. In consequence of its strong

emetic properties, it is, in most cases, soon rejected from the stomach; but in a case reported by Dr. Gibb, in which 67 grains, contained in a lotion, was swallowed by an adult female, there was no vomiting from the poison, and some difficulty in relieving the stomach by emetics. It has been administered medicinally in doses of two scruples three times a day for several weeks, without injurious consequences. (Dr. Babington.)

The Post-mortem Appearances are those of simple inflammation of the mucous membrane of the stomach and intestines.

Treatment.—A dilute solution of carbonate of potash or soda as an antidote, followed by the free administration of milk, of the white of egg in large quantity, and of liquids containing tannin, such as tea, and decoctions of oak or Peruvian bark. The rest of the treatment is that common to the irritant poisons.

Chloride of Zinc.—A concentrated aqueous solution of this substance (about 200 grains to the ounce) is the disinfectant known as "Burnett's Fluid." It is a strong corrosive poison; and produces the symptoms and post-mortem appearances common to the class of corrosives; sometimes with the addition of nervous symptoms. It has more than once proved fatal, and death has occurred in as little as four hours.

TIN.—*Chlorides of Tin.* There are two chlorides of tin, the protochloride and the perchloride, in the form of yellowish-white acicular crystals. A mixture of these two salts in solution is known as *dyers' spirit.* These are the only preparations of tin which require notice.

Tests. — The *protochloride* has the following properties:— 1. Sulphuretted hydrogen throws down a precipitate of a dark chocolate colour; also the sulphide of ammonium, the precipitate being soluble in excess of the reagent. 2. The bichloride of mercury gives a grey precipitate of finely divided mercury. 3. Chloride of gold gives a deep purple precipitate (the purple of Cassius). 4. A fragment of zinc placed in a drop of the solution throws down the metal in an arborescent form, characterized, though not distinguished, by the rectangular arrangements of the branches (fig. 96). One grain of the protochloride in two ounces of distilled water gives characteristic results. The acid is detected by the white precipitate, insoluble in nitric acid, thrown down by nitrate of silver.

Fig. 96.

The *perchloride* is precipitated yellow by sulphuretted hydro-

gen, and sulphide of ammonium, the precipitate being soluble in an excess of the sulphide. In colour, therefore, the precipitated sulphide resembles the sulphides of arsenic and of cadmium. It differs from the former in being insoluble in ammonia, and from the latter in being insoluble in hydrochloric acid. Corrosive sublimate and chloride of gold give no precipitate with the perchloride. The acid of the salt may be detected by nitrate of silver.

The salts of tin produce the common symptoms of irritant poisoning, which must be met by the free use of albumen or milk, and of diluents. Emetics, or the stomach-pump may be employed if necessary.

SILVER.—*Nitrate of Silver* (Lunar Caustic).—This substance occurs in the form of tabular crystals, or fused into small cylinders. It has the following properties:—It is very soluble in distilled water. Its solution has an acid reaction, and a strong styptic, metallic taste. It is a very powerful corrosive; and, when mixed with organic matter, is blackened by light. The base is detected by the following tests:—1. Sulphuretted hydrogen or sulphide of ammonium yields a black precipitate. 2. Liquor ammoniæ throws down the brown oxide, which is dissolved by the precipitant in excess. 3. Hydrochloric acid yields a white clotted precipitate, the chloride of silver, which is insoluble in nitric acid, and when heated on platinum-foil fuses into a horny mass. 4. On adding to the solution liquor ammoniæ, until the brown oxide is redissolved, and then arsenious acid, the yellow arsenite of silver is thrown down. 5. A strip of copper introduced into the solution is speedily coated with silver. 6. If a minute fragment of zinc is placed in a drop of the solution, the metallic silver is deposited in an arborescent form (fig. 97).

Fig. 97.

This test is very delicate, a distinct tree (generally in the shape of the shaded figure) being obtained from a grain in eight ounces of water. The acid is detected by adding to the filtered liquid remaining after the application of the tests, carbonate of potash, when nitrate of potash is formed.

No detailed cases of poisoning by nitrate of silver have been placed on record, but from experiments on animals, it appears that it acts as a simple corrosive and local irritant.

The *treatment* consists in changing the soluble nitrate of silver

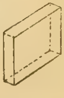
to the insoluble chloride, by the free use of a solution of common salt.

Iron.—The sulphate of iron (green vitriol, copperas) and the chloride, or muriate, of iron possess sufficiently active properties to entitle them to rank as poisons. The base may be detected by the following tests:—1. Sulphuretted hydrogen gives no precipitate, but the sulphide of ammonium throws down a black sulphide. 2. Infusion of galls also gives a black precipitate. 3. Ferrocyanide of potassium throws down a blue precipitate, which deepens by exposure to the air. 4. Sulphocyanide of potassium gives a deep blood-red precipitate. The acid in combination in the sulphate and muriate, respectively, may be detected by the nitrate of baryta and nitrate of silver tests.

The *sulphate of iron*, and the *chloride* in the form of tincture, have both proved fatal, and have in one or two other instances produced severe effects. The symptoms and post-mortem appearances in one case of poisoning by the tincture, recorded by Dr. Christison, were those of a strong irritant. The treatment would consist in the free use of emetics and diluents.

Bismuth.—*Trisnitrate, subnitrate, or nitrate of Bismuth.*—This substance has proved fatal in a large dose, with the symptoms and post-mortem appearances proper to irritant poisoning. It is found in the form of a white, insoluble powder, which is blackened by sulphuretted hydrogen, and sulphide of ammonium. It is soluble in nitric acid, but it is again thrown down when the solution is largely diluted with water. The solution resembles that of the salts of lead in being precipitated white by liquor ammoniæ and liquor potassæ, but differs from it inasmuch as it gives no precipitate with dilute sulphuric acid. It gives a deep-brown precipitate with iodide of potassium.

Chrome.—Two salts of chrome—the neutral chromate, and the bichromate of potash—are manufactured on a large scale and extensively used as dyes. The *chromate of potash* has a bright yellow colour, and disagreeable bitter taste. It is the common source of the other compounds of chrome. The *bichromate of potash*, known also as *red chromate*, is much used as a dye. It consists of deep orange-coloured crystals, of the form annexed, or as long flattened prisms. It is very soluble, and yields, according to quantity, a rich orange or a yellow solution, with an acid reaction. With the salts of lead it gives a yellow, and with those of silver a deep-red precipitate.



Experiments on animals show that it has the properties of a strong irritant poison; and it has more than once proved fatal to man. In one case, communicated to Dr. Taylor by Mr. Wood of St.

Bartholomew's Hospital, two drachms killed a woman in four hours, with symptoms of violent irritation, and the post-mortem appearances of a corrosive poison. The appropriate treatment would be by diluents and demulcents. In solutions of moderate strength the bichromate assumes the forms shown in fig. 98. In dilute solutions ($\frac{1}{100}$) it takes on the arborescent form shown in fig. 99.

Fig. 98.

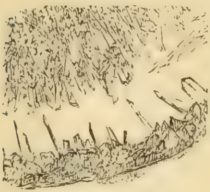


Fig. 99.

Solution 1 in 100.

The crystals from strong solutions are coarse square plates and flattened prisms. The crystalline form of the weaker solution is important, inasmuch as this solution constitutes a very valuable test for strychnia and some other alkaloids.

Workmen engaged in the manufacture of the bichromate of potash suffer much from chronic sores on the hand, and occasionally on the feet and shoulders. The foundation for the sores is laid in some lesion of the skin, on which the poison acts as a caustic, producing a tough slough, followed by an ulcer with hardened cup-like border. Attacks of conjunctivitis are also of not uncommon occurrence, and more serious results occasionally follow from the introduction between the lids of the strong solution. I am indebted for this information to Dr. Eadie, of Glasgow.

Thallium.—It will suffice to mention the salts of this metal, as having been proved, by experiments on animals, to have a poisonous action.

CHAPTER IX.

NARCOTICS.

OPIUM AND ITS PREPARATIONS.

The *inorganic poisons* having been treated of in five successive chapters, the remainder of this work will be devoted to the *organic poisons*, beginning with the most important of their number, opium. Of the 543 cases of poisoning investigated in the Coroner's court in England and Wales, during 1837–38, 200 were cases of poisoning by opium and its preparations, either alone or in union with other poisons; 184 having been the number of cases of poisoning by arsenic. Of these 200 cases, 42 were by opium, 133 by laudanum, 21 by other preparations containing opium, 2 by acetate of morphia, and 2 by laudanum and prussic acid, and laudanum and aquafortis respectively: 64 of the 200 occurred in children, the remainder in adults; and of these 64, 41, or a fifth of all the cases, were from over-doses of cordials or medicines, given to infants and young children by mothers or nurses.

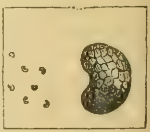
Since the years 1837–38, in consequence partly of the legal enactment restricting the sale of arsenic, partly of the increased knowledge of the properties of other poisons, opium and its preparations, which then figured as four in eleven of all the recorded poisons, constituted on the average of the five years 1852–56 more than one-half. The annual average of deaths by ascertained poisons being 268, no less than 141 were attributed to opium and its preparations (opium 34, laudanum 89, Godfrey's cordial 16, morphine 2), while prussic acid and its compounds accounted for 34 deaths, and arsenic and its preparations for only 27 deaths.

In these five years, 1852–56, the ages of the victims were ascertained in 377 instances; and it was found that 170, or nearly half, occurred in infants under one year of age, and 203 in children under five years old. Only one murder and one manslaughter (by laudanum) are reported in the whole five years. But opium and its preparations, and laudanum especially, are sometimes given to facilitate the commission of other crimes, such as theft and rape; the taste and colour being generally concealed in brandy or coffee, and the sense of taste deadened by intoxicating liquors.

The *capsules* of the Papaver somniferum (white, or garden poppy) (fig. 100) furnish several preparations to the British Pharmacopœia—a decoction for external use, a syrup given chiefly to infants, and an aqueous extract (extractum papaveris), in addition to the inspissated juice known as opium. A decoction of the capsules, or poppy heads, not authorized by the Pharmacopœia, is sometimes given to infants with fatal effect. As the seeds from the capsule have been found in the stomach, and as the seeds taken by themselves have proved fatal in some instances abroad, their size and microscopic character are shown in fig. 101. They weigh about 230 to the grain. Some are white, others grey.

Fig. 100.

Fig. 101.



Opium, the inspissated juice of the unripe capsules, has the following familiar properties:—It is of a reddish-brown colour, of a strong and peculiar odour, and has a bitter and rather acrid taste. Different specimens of the drug vary in physical properties, and in activity, with the place and year of growth, the maturity of the capsules, the greater or less care bestowed on the manufacture, and the presence or absence of adulteration. The drug consists of a number of distinct principles combined with a peculiar acid, and mixed with resin, and extractive matter. These principles are dissolved by water at ordinary temperatures, by alcohol, and by mineral and vegetable acids.

The preparations of opium in the British Pharmacopœia are:—The tincture, or *Laudanum*, which contains one grain in about fifteen minims; the ammoniated tincture, which has five grains to the ounce; the compound tincture of camphor, or *Paregoric*, which contains one grain in the half ounce; the extract and liquid extract of opium; the compound powder, of which one-tenth part is opium; the confection, which contains about one grain in forty; the compound ipecacuanha, or Dover's powder, which contains one grain in ten; the aromatic powder of chalk and opium, which contains one grain in forty; and the compound kino powder, which contains one grain in twenty; the

compound soap pill, which contains one part in five; the lead and opium pill, one part in eight; the ipecacuanha and squill pill, one part in sixteen and a half; and the opium lozenges, which have $\frac{1}{10}$ grain of the extract in each. The vinum opii (twenty-two grains of the extract to the ounce); the enema opii, consisting of thirty drops of the tincture in ℥ij of starch; the emplastrum opii (one in ten); the unguentum gallæ c. opio (gr. thirty-two to ℥j); complete the long list of pharmacopœial preparations containing opium.

The *black drop* said to contain two, three, or four times as much opium as the tincture, and Battley's liquor opii sedativus, of which twenty drops are said to be equal to thirty of laudanum, are also in common use. The first is made with verjuice and aromatics, the second is believed to be an aqueous solution. Godfrey's cordial, Dalby's carminative, children's quietness, and several mixtures improperly given to children to procure sleep, contain laudanum, in variable quantity, as their chief ingredient, in combination with syrups, stomachics, and magnesia.

Opium contains several active principles. Morphia, narcotine, narceine, meconine or opianyl, thebain or paramorphia, codeine, papaverine, and cryptopia, have been separated; but the most important, in a medico-legal point of view, are *morphia* and *meconic acid*, combined in opium as a *meconate of morphia*. Opium may be recognised by the reactions of these two substances, as well as by its odour and other physical properties.

The morphia and meconic acid are extracted and separated by the following process:—The opium is infused in successive portions of cold water. This aqueous solution, holding the active principles of the drug dissolved, is boiled with magnesia, which combines with the meconic acid and carries down with it the active principles. The mixed precipitate thus formed, after being washed and dried, is boiled with proof spirit, which dissolves the narcotine and the resin, leaving the morphia and meconate of magnesia behind.

To separate the *morphia* the precipitate is boiled in strong alcohol, which dissolves it mixed with some resin. From this impure spirituous solution, the morphia may be obtained pure by repeated crystallization.

To separate the *meconic acid*, the impure meconate of magnesia is boiled in dilute sulphuric acid, and the mixture partially evaporated. The sediment that falls on cooling is dissolved in water, and acetate of lead added. A meconate of lead is thus formed, which is washed and suspended in water, and a stream of sulphuretted hydrogen gas transmitted through it. Sulphide of

lead is thrown down, and meconic acid left in solution; and on evaporation, impure scaly crystals of the acid are obtained.

TESTS FOR MORPHIA AND MECONIC ACID.

MORPHIA (*Properties*):—1. It is sold as a white powder, or as crystals, which are generally more or less discoloured by resin; but when quite pure are colourless. They are six-sided prisms (fig. 102); and crystals, or the fragments of crystals, of this shape may be recognised in good specimens of the alkaloid. When thrown down from a solution of one of its salts (*e.g.*, the acetate) by exposure to the vapours of ammonia, it assumes the forms shown in fig. 103. 2. They have a bitter taste, but no odour. 3. When heated on platinum foil, they melt into a yellow oily liquid, burn like a resin, leaving a carbonaceous deposit of a semi-crystalline appearance, and giving out ammonia. 4. When heated on a porcelain slab, they yield a crystalline sublimate presently to be described. 5. They are very sparingly soluble in water, but more soluble in ether, and still more so in alcohol; soluble also in the caustic alkalies, and in the mineral and vegetable acids, combined with which they are used in medicine. 6. Their solution has a slight alkaline reaction. 7. In common with other alkaloids, morphia is precipitated from its solutions by tannin.

Fig. 102.

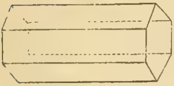
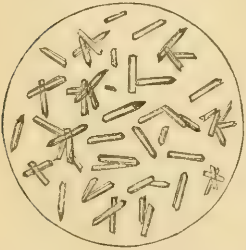


Fig. 103.



Tests.—These are best applied to morphia in *substance*. When, therefore, the alkaloid is presented to us in the solutions of its salts, it is convenient to expose drops of the solution on glass disks, or porcelain slabs, to the vapours of ammonia, so as to get deposits of the alkaloid itself.

1. *In substance.*—If we have reason to believe that a white powder, or a colourless or straw-coloured crystal, belongs to the class of alkaloids, we confirm the suspicion by heating it on a clean slab of white porcelain, with glass disk superimposed (fig. 47, p. 384). The substance darkens, melts, smokes, deposits a black stain, and yields a sublimate presently to be described. The powder or crystal is therefore probably an alkaloid. If, now, we place a small quantity of the powder on a clean porcelain

slab, and dissolve it in a drop of strong sulphuric acid, it undergoes no change of colour, but turns light brown when warmed by the flame of the spirit-lamp, and dark brown when heated. If the heat is continued the liquid becomes almost black, and gives off an abundant irritating vapour, having an odour as of singeing. This reaction confirms the effect of heat, and we now prove the powder to be morphia by the following tests, applied as before on a clean slab of white porcelain:—1. Nitric acid. 2. Permuriate of iron. 3. Iodic acid and starch. 4. Sulphuric acid and bichromate of potash.

1. *Nitric Acid.*—This acid dropped on the alkaloid changes it to a rich orange colour, and dissolves it with effervescence, and the production of ruddy fumes of nitrous acid.

2. *Permuriate of Iron.*—This test (which should be neutral) strikes with the powder a rich indigo-blue, turning to green when added in excess.

3. *Iodic Acid and Starch.*—Dissolve a small quantity of the acid in a drop of cold freshly-made starch, place it on the white slab, and introduce the powder or crystal. Iodine is set free, and produces the characteristic blue iodide of farina.

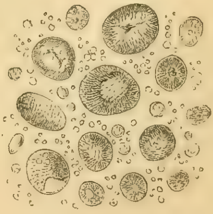
4. *Sulphuric Acid and Bichromate of Potash.*—Cold strong sulphuric acid added to morphia, produces, as just stated, little or no effect; but on adding a solution of bichromate of potash, the mixture assumes a rich brown tint, passing rapidly to green, due to the reduction of the oxide of chromium.

These four tests are delicate and characteristic, and, both separately and collectively, conclusive of the presence of morphia.

Sublimates of Morphia.—Morphia sublimes at the high temperature of 330°, melts when the heat is raised to 340°, and still

Fig. 104.

Fig. 105.

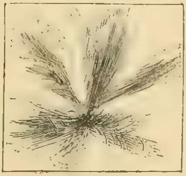


continues to yield sublimates till it is reduced to a black spot of carbon. The sublimate often assumes the form of white circular

spots, obviously crystalline, and displaying under the microscope foliated curved lines as in fig. 104. But when the temperature of the glass disk approaches that of the surface of porcelain, the sublimates consist of prismatic crystals, distinct or grouped as in fig. 103. At lower temperatures they are made up of distinct striated globules or watered patterns, and sometimes they contain dark feathery crystals. The striated globules are shown in fig. 105. The best results are obtained with quantities of the alkaloid not exceeding the one-hundredth of a grain. Such minute quantities will yield many successive sublimates characteristic in their forms and reactions. These sublimates, whatever shape they assume, are highly soluble in several reagents, and yield with them crystals of very beautiful and characteristic forms.

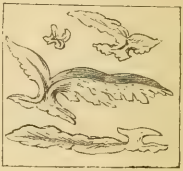
The figures annexed represent four of these crystalline forms. Fig. 106 shows a marginal group of needles from a sublimate

Fig. 106.



× 15.

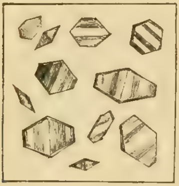
Fig. 107.



× 50.

treated with dilute hydrochloric acid ($\frac{1}{20}$). Fig. 107 shows the reaction with spirits of wine; fig. 108 those with liq. ammoniæ;

Fig. 108.



× 75.

Fig. 109.

× 50.

and fig. 109 the winged (fly-like) crystals often resulting from the treatment of an amorphous sublimate with distilled water. These reactions should be watched as they occur under the microscope. Sometimes they are instantaneous, and almost always quick in showing themselves.

Meconic Acid.—This consists of scaly crystals, which when impure are dusky red, when purer a pale yellow, and when quite pure, colourless. Under the microscope they are seen as mottled plates of various sizes, shapes, and thickness. They are soluble in water, and the solution has a strong acid reaction. When heated on white porcelain they readily melt, and assume the form of coarse white plates, and under a greater heat darken, smoke, and melt, yielding a white amorphous sublimate, and leaving a scanty black deposit. The acid is thrown down from its solutions by acetate of lead as a white meconate, insoluble in acetic acid. This substance is not poisonous. The only test of any value for meconic acid, whether in crystals or in solution, is also one of the tests for morphia, viz.:—

Permuriate of Iron.—This strikes with meconic acid an intense cherry-red colour, discharged by solution of protochloride of tin, but not by the dilute mineral acids, or by the solutions of bichloride of mercury and chloride of gold.

The test gives a similar reaction with sulphocyanide of potassium, with saliva which contains that salt, with common mustard in solution, and with the alkaline acetates; but this fact does not constitute an objection to the test for meconic acid when obtained from a solution of opium, or from an organic fluid by the process now to be described.

The successful action of this test for meconic acid strongly confirms the tests for morphia as evidence of the presence of opium in the liquid from which they were both obtained.

Opium in Organic Mixtures.—The presence of opium in an organic mixture may be inferred from its yielding with nitric acid and permuriate of iron respectively the orange colour due to the presence of morphia, and the red colour due to the meconic acid. These indications may be obtained by diluting the organic liquid till its colour is such as not to interfere with the reactions.

The process for organic mixtures should obviously be one which separates both the alkaloid and the acid. A solution of opium itself may be regarded as a suspension of its active principles in an organic mixture; for opium, in addition to those principles, contains a large amount of resin and extractive matters. The process for the detection of the morphia and meconic acid in the contents of the stomach is as follows:—The solid matters, if any, are to be cut into small fragments, and well mixed with the liquid, distilled water being added if necessary. The mixture is then to be acidulated with acetic acid, and treated with a solution of acetate of lead, so long as any precipitate falls.

The liquid is then to be well shaken, and after standing for a time, thrown on a wet filter. An impure meconate of lead remains on the filter, while the fluid part contains the morphia as acetate, with free acetate of lead. The precipitated impure meconate of lead, suspended in a little distilled water, is now treated with excess of sulphuretted hydrogen. Sulphide of lead is formed, and meconic acid remains in solution. This solution is changed to a dark red colour by permuriate of iron; and, being concentrated by evaporation, yields crystals of meconic acid. The fluid part which contains the acetate of morphia is next to be treated with sulphuretted hydrogen, and any lead it may contain thrown down as sulphide. The liquid must again be filtered, and being reduced by evaporation to the consistence of a syrup, is to be over saturated with carbonate of potash, and shaken up with ether. The ethereal solution, on being drawn off, and allowed to evaporate, deposits crystals of morphia, which may be identified by its several tests. The meconic acid may be tested in like manner.

Though this method of procedure will often furnish satisfactory evidence both of morphia and meconic acid, it will sometimes fail. Indeed large quantities of the fluid preparations of opium may be taken, and yet be detected neither by odour, taste, nor chemical tests, even when death takes place most rapidly; and it is now well understood that, in cases of poisoning with opium, the best methods of analysis yet known will often fail in procuring satisfactory evidence, and sometimes fail to obtain any evidence at all, of the existence of the poison in the contents of the stomach. Even the odour has been absent in the liquor removed half an hour after an ounce and a half of laudanum had been taken on an empty stomach, and when present it may be so mixed up with other odours, that it cannot be recognised with certainty.*

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—There is so much difference in the symptoms present in different cases of poisoning by opium, and at different stages of the action of the drug, that it is impossible to give the history of an average case of poisoning within the ordinary compass of a single description.

The symptoms due to a poisonous dose of opium, or its preparations, are giddiness, drowsiness, and listlessness, followed by stupor, passing by degrees into a state of complete insensibility. The patient lies as if in profound sleep, breathing slowly and almost imperceptibly, with eyes shut, pupils contracted and in-

* Bright's 'Reports of Medical Cases,' ii. 203.

sensible to light, pulse either very frequent, or full and slow, the skin warm and moist, and the face flushed. At first the patient can be easily roused by loud noises, sudden movements, or slight blows; but, in a more advanced stage, he is kept awake with great difficulty, by violent shaking, loud speaking, tickling the nostrils, injecting water into the ear, or flecking the hands and feet with a towel; and at length falls into a state of complete coma, with stertor, slow and noisy respiration, a slow and full pulse, a pale and ghastly countenance, cold and damp skin, and livid hands and lips. Nausea and vomiting are sometimes present from the first, but in other cases they are among the early signs of recovery. When the patient is kept roused, by being briskly moved about, he is subject to constant retching, even though no emetic has been used. The bowels are generally confined. In fatal cases death may take place from apoplexy, in a state of collapse, from apnœa, in convulsions, or in a palsied state. In patients who recover, a long deep sleep, with a remarkably slow breathing (I have counted it in a female as low as 6 in the minute, while the pulse was upwards of 80), is followed by a stage of painful nervous excitement, with headache, and distressing nausea.

Occasional Symptoms. — Spontaneous vomiting, diarrhœa, diuresis: delirium, convulsions (most common in children), sometimes alternating with stupor, locked-jaw and tetanic spasms, paralysis, anæsthesia, dilated pupils, or one pupil dilated the other contracted, and the reflex function active and easily excited, though the patient is otherwise quite insensible. The *pulse* sometimes nearly natural in frequency and force; in other cases full and quick, but this chiefly in the first stage. In the stage of insensibility, while the patient can still be roused, the pulse is generally full and slow, but towards the fatal termination it becomes small, frequent, and irregular. The respiration is much more uniformly affected than the pulse. Itching and dryness of the skin are also among the occasional symptoms.

Anomalous Cases.—An absence of the usual narcotic symptoms, with sudden death. A long postponement of the symptoms. Recovery for a time, with fatal relapse.

Post-mortem Appearances.—These are neither constant nor well marked. That most frequently observed is turgescence of the vessels of the brain, with or without serous effusion under the arachnoid, into the ventricles, at the base, and around the spinal cord; very rarely accompanied by extravasation of blood. The stomach and intestines are generally healthy. Lividity of skin, congestion of the lungs, a fluid state of the blood, and early putrefaction are among the less constant appearances.

First Appearance of Symptoms.—The poison, when taken in large quantity, and in a fluid state, may begin to act within a few minutes, and coma may be fully formed in half an hour. Even when taken in the solid form, complete stupor has been present in as little as fifteen minutes. Sometimes, however, the action of even a large dose of the poison is postponed for half an hour, an hour, or an hour and a half; and cases are on record in which large quantities of the poison have not produced any serious effect till the lapse of 3, 5, 9, 10, and even 18 hours. A curious case of this kind was published in the 'Lancet,' July 15, 1857, by Dr. Gibbs. Twelve drachms of laudanum were spontaneously rejected from the stomach at the end of nine hours, without having given rise to any marked symptoms. The patient was a little exhausted, and the pupils were contracted.

The action of the poison is more prompt when taken on an empty than on a full stomach; when in a liquid state than when swallowed in the solid form; when the patient remains still than when he takes exercise immediately after swallowing the poison; and it is probable that the action is postponed and diminished by spirituous liquors.

Fatal Period.—*Shortest*, three quarters of an hour. Cases of death in about *two* hours are not uncommon; few cases are prolonged beyond *twenty-four*, and the *average* may be stated at from *seven* to *twelve* hours. When a patient survives *twelve* hours there is good hope of recovery.

Fatal Dose.—Smallest, about four grains. A quantity of the extract equivalent to four grains of opium has destroyed life. Enormous quantities have been taken with impunity. In one instance recovery took place after no less than eight ounces.

In very young children extremely small doses produce very marked effects, and have proved fatal. Cases are on record in which an eighth of a grain of opium, or its equivalent, has killed an infant two days old, a sixth of a grain an infant of four, and another of five days, a fifth of a grain an infant of three days old, a third of a grain an infant of nine months, and another a few weeks old, a fourth of a grain a child of fourteen months, less than half a grain a child of four years and a half. Two drops of laudanum killed an infant. Severe symptoms have been produced by a single grain of Dover's powder, containing a tenth of a grain of opium. A child of four months, and several infants, have suffered severely from quantities of laudanum equivalent to the sixth of a grain of opium.*

* For details of such cases, with the particular preparations given, see the standard works on Toxicology.

Death has happened, in the instances referred to, in intervals of time varying from 7 to 18 hours. As in the adult, so in infants and young children, recovery has taken place after considerable doses of opium. In a case under my own observation a child of six months recovered from ten grains of Dover's powder.

There are some persons on whom comparatively small doses of opium and its preparations, in consequence of peculiarity of constitution, produce unusually severe effects. On the other hand, the power of habit in lessening the effect of the poison must not be overlooked.

Opium, like tobacco, may be taken in constantly increasing doses with impunity. Thirty grains of solid opium, and even one hundred grains, are often taken in the day by opium eaters; and De Quincey, the English opium-eater, brought himself to take nine ounces of laudanum, equivalent to 333 grains of solid opium, in the day. There is scarcely a druggist in London who has not seen laudanum swallowed by the wineglassful; and I am informed that the Lascar beggars purchase half an ounce of opium a day, from which they procure a watery extract to smoke with tobacco.

Opium, thus taken habitually in large quantities, and for long periods, causes emaciation and loss of vigour, loss of appetite, and constipation, loss of mental vigour, severe neuralgic pains, premature old age, and early death. Hobhouse describes the opium-eaters of Constantinople as "pale, emaciated, and rickety, sunk into a profound stupor, or agitated by the grimaces of delirium." Mr. Madden and Dr. Oppenheim confirm this account. The former adds, that a regular opium-eater seldom lives beyond thirty years, if he commences the practice early; and the latter tells us that such persons seldom attain the age of 40.

In the face of these statements, and of the extreme improbability that a habit so unnatural should not affect the duration of life, it has been denied that the practice of opium-eating tends to shorten it. There is no doubt that many persons who indulge in it (but in a less degree than in the cases referred to by Hobhouse, Madden, and Oppenheim), live to a good age; but it is probably with opium as with spirits and tobacco:—those who indulge in them and live long would attain a much greater age if their habits of life were other than they are.*

Opium applied to the skin, and especially to an abraded surface, or used as an injection, or introduced into the nostril or ear, may produce dangerous or fatal results. M. Tournon, of Bordeaux, relates a case in which death was attributed to four grains of opium introduced into the ear.

* For cases, see Christison on the case of the Earl of Mar, p. 661.

Treatment.—The treatment must begin with the use of the stomach-pump, and warm water should be freely injected and withdrawn till it is discharged without odour and colour. If the stomach-pump cannot be immediately applied, an emetic of sulphate of zinc should be given; or, if this is not at hand, a tablespoonful of mustard, mixed with water. At the same time vomiting should be encouraged by the free use of warm water, and by tickling the throat with a feather. If the patient is comatose, cold water should be freely dashed over the face, head, and neck, till he is somewhat roused from the stupor, and he must then be kept awake by causing him to walk rapidly between two assistants, shaking him and shouting to him. In small apartments, where it is inconvenient to move the patient about, he may be kept roused by flecking the hands and feet with a towel. When he is beginning to recover, strong coffee should be freely given. If emetics by the mouth do not act, they may be injected into the bowels, and, in hopeless cases, a solution of tartar emetic might be introduced into a vein. A current of magneto-electricity passed from the spine through the chest, and artificial respiration, have been used in extreme cases. When the symptoms present are those of collapse, ammonia may be freely given internally and applied to the nostrils; when those of apnœa, warmth and friction to the surface are indicated; when those of cerebral congestion, the moderate abstraction of blood by leeches. In the excited state which follows recovery, as well as in the early stage of the poisoning, cold affusion has been practised with excellent effect.

As there are several reagents which precipitate morphia from its solutions, some of these have been proposed as antidotes in poisoning by opium and its preparations. Tannic acid was recommended by Orfila, and solutions of iodine and bromine have also been suggested. The proposal to administer iodine has been lately revived by Dr. Fuller, who suggests a dilute solution of this substance as an antidote.*

As narcotism (the common effect of opium) and delirium (the leading symptom of belladonna poisoning) are strongly contrasted conditions, it has been inferred that the one poison would prove an antidote for the other. Accordingly two American physicians, Drs. Horton and Norris, have published cases of recovery from poisoning by opium which have seemed to be due to the use of belladonna, and of poisoning by belladonna thought to be equally due to the employment of opium. But Dr. John Harley's recent experiments, conducted by the hypodermic method, have proved conclusively that morphia and atropia are so far from exercising an antagonistic

* 'Lancet,' March 21, 1868.

influence on each other, that their combination greatly increases the effect of either. It is obvious, therefore, that the recoveries in the cases referred to have taken place, not only independent, but even in spite of, the reputed antidote.*

MORPHIA AND ITS SALTS.

Of this alkaloid, which is found in opium in proportions varying from 2 to 28 per cent., the best kinds averaging about 10 per cent., there are two salts—the acetate and hydrochlorate, which supply preparations to the British Pharmacopœia—namely, the liquor morphiæ acetatis and the liquor morphiæ hydrochloratis, which contain one grain of the salt in 2 drachms. Also the suppository, which contains half a grain of the hydrochlorate, and the lozenge of morphia, as well as the compound lozenge of morphia and ipecacuanha, containing in each lozenge the 36th of a grain. The hydrochlorate is the preparation in most common use, and its ordinary dose for an adult is an eighth of a grain. The acetate is sold as a snow-white powder, or imperfectly-formed crystals; and the hydrochlorate either as a white powder, or in the form of silky acicular crystals. Both have the chemical reactions of morphia itself.

Symptoms.—Those of opium and its preparations. The symptoms set in somewhat earlier, and contraction of the pupils, with great dimness of vision or actual blindness, is very constant. Intense itching of the skin is also very common, and dysuria, tetanic spasms, and strong convulsions are among the occasional symptoms.

Anomalous Cases.—In one case reported by Dr. Shearman,† a grain and a half of the acetate of morphia in divided doses caused twitching of the limbs and face, difficulty in swallowing, spasms of the muscles of the arms, legs, and abdomen, partial opisthotonos, and great activity of the reflex function. Morphia was found in the urine. The patient recovered. A similar case of poisoning by twenty-two grains of the muriate of morphia, in which locked jaw, tension of the abdomen, and occasional convulsions, were present, is related by Orfila, and cited by Christison (p. 725). In one case, also, delirium seems to have followed its application to a blistered surface.

It is worthy of observation that Auguste Ballet, the presumed victim of Castaing, had, in addition to vomiting and purging, convulsions, locked jaw, rigid spasms of the neck and abdomen, inability to swallow, loss of sensibility in the legs, contracted

* See an abstract of Dr. Harley's Lectures in the 'Pharmaceutical Journal,' April, 1868, p. 471.

† 'Med. Times and Gazette,' March 7, 1857.

pupils and stertorous breathing; and that Castaing, who prescribed for Ballet, and gave him food and medicine, was proved to have recently purchased twelve grains of tartar emetic, and twenty-six grains of acetate of morphia.

John Parsons Cook, the victim of William Palmer, took two pills containing half a grain of acetate of morphia on each of the two nights preceding his first attack; and on the night of the attack itself two pills were given by Palmer, and again two pills on the occurrence of the tetanic symptoms. On the succeeding night, which was the night of his death, Cook also took two pills given him by Palmer, who had previously obtained the acetate of morphia pills from the medical attendant; and during the fatal attack two other pills, said to contain ammonia. If all these pills contained acetate of morphia in the dose first prescribed, an aggregate of three grains would have been given within three days, of which quantity two grains were administered in little more than twenty-four hours. As the lady attended by Dr. Shearman was severely attacked with symptoms of tetanus from taking three doses of half a grain of acetate of morphia within seven hours, it is quite possible that the same drug in the same dose, and in the aggregate three grains in the space of seventy-two hours, may have proved fatal to a patient previously reduced by tartar emetic. It is not intended by these observations to raise any doubt of the guilt of Palmer, but merely to suggest the possibility of the death of Cook having been occasioned by acetate of morphia and not by strychnia.

Fatal Dose.—In the case of this, as of most other active poisons, very large doses have been taken with impunity, and very small ones, in certain states of system, have been followed by dangerous symptoms. In one case half a grain of the acetate of morphia given as a medicine to a female in ill health was supposed to have proved fatal,* and it is probable that less than a grain given in one dose would kill an adult. One grain injected under the skin in three doses of one-third of a grain each, within about twelve hours, appears to have proved fatal to a man under the care of Mr. de Morgan.†

Treatment.—That proper to poisoning by opium and its preparations. The stomach-pump should be employed without delay. If not at hand, finely-divided animal charcoal suspended in water might be administered with advantage, or solutions containing tannic acid, as strong green tea, or tincture of iodine largely diluted with water.

* 'Lancet,' Nov. 1838.
† Taylor's 'Principles and Practice of Medical Jurisprudence,' p. 291.

CHAPTER X.

DELIRIANTS.

1. BELLADONNA.
2. HYOSCYAMUS.
3. STRAMONIUM.
4. SOLANUM NIGRUM.
5. SOLANUM DULCAMARA.
6. SOLANUM TUBEROSUM.
7. CAMPHOR.
8. ŒNANTHE CROCATA.
9. COCCULUS INDICUS.
10. LOLIUM TEMULENTUM.
11. POISONOUS FUNGI.

THE poisons belonging to this group are characterized by the common property of causing delirium, with illusions of the senses; coupled with extreme dilatation of the pupil. Other poisons which affect the nervous centres either do not give rise to delirium, or they produce it only exceptionally; and, if they dilate the pupil, it is less constantly, and in a less degree. Irritation of the stomach and bowels is present in a certain number of cases, and dysuria, or suppression of urine, is not uncommon. The first three poisons are the most important of their class; the others have less interest, and are more briefly noticed; the reader being referred for more ample details respecting them to treatises on toxicology.

I. BELLADONNA (*Atropa Belladonna, Deadly Nightshade*).

This is a plant of the Linnæan class and order, *Pentandria Monogynia*, and natural order, *Solanaceæ*. It is indigenous, and grows in waste shady spots in some parts of England, flowering in June and July, and yielding ripe berries in September. Fig. 110 shows a cutting of the plant in flower, and a berry, whole and in section. The plant has a lurid hue, and when bruised, gives out a faint fœtid odour. Cases of poisoning by the *root*, *leaves*, and *berries*, and by the medicinal *extract*, are on record, several of which proved fatal. A decoction of the root, given as a clyster, has also caused death; and serious symptoms have followed the external application of the extract to a blistered surface. The leaves and root of the plant are admitted into the British Pharmacopœia. A tincture (one ounce to a pint, dose 5

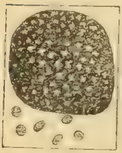
Fig. 110.

to 20 minims) and an extrac (one ounce to a pint) ar obtained from the leaves and a liniment (one ounce t a pint) from the root. Th extract is used for makin the ointment and plaste (80 grains to the ounce, an 50 per cent. respectively).

The plant owes its poi sonous properties mainly t the alkaloid *atropia*, whicl has been admitted into th British Pharmacopœia, witl one of its salts, the sulphate The alkaloid supplies th liquor atropiæ (4 grains t the ounce), and an ointment (8 grains to the ounce); an the salt, the liquor atropiæ sul phatis (4 grains to the ounce).

The parts of the plant that have been taken as poisons are readily recog nised. The *root* is thick and fleshy, branched and creeping; its section, white when fresh, and greyish when dried; and it has a slightly bitter taste. The *leaves*, often in pairs of unequal size, ovate and undivided, smooth and soft, are attached to the stem by short foot-stalks. The *berries*, of the size of a small cherry, with a deep central furrow, shining violet black colour, and sweetish taste, are enclosed in the enlarged calices, and have two cells, containing several seeds. They contain a liquid which stains white paper a rich durable purple. The *seeds*, of the small size shown in fig. 111, with circular, oval, or kidney-shaped outline, and rounded surface, are nut-brown in colour, and weigh about ninety to the grain. When seen by the lens, they look like sultana raisins in miniature. When seen by reflected light under a low power of the microscope, they have the appearance shown in the figure, and are studded closely with equal small round projections.

Fig. 111.



As all parts of the berries, as well as the seeds, are very indigestible, portions of them will be found, in cases of

poisoning, in the matters rejected by the stomach, or passed from the bowels.

Symptoms.—Dryness of the lips, mouth, and throat, with difficulty of swallowing, or even total inability to swallow, and impaired utterance, or loss of voice; thirst; giddiness; numbness of the extremities, staggering gait; great mental excitement; delirium, gay or furious, with spectral illusions; ending in coma, or alternating with it; the pulse accelerated; the countenance flushed and swollen; the pupils largely dilated; the eyes prominent and sparkling; the vision indistinct or lost. In fatal cases, death is ushered in by comatose symptoms, but rarely by convulsions. Irritation of the alimentary canal, beyond dryness and constriction of the throat, is rare; but nausea and unsuccessful efforts to vomit are recorded in some cases, and aphthous inflammation of the throat, swelling of the abdomen, and discharge of blood by stool, in at least one instance. Violent strangury, suppression of urine, or involuntary discharge of it, with excitement of the genitals, and hæmaturia, have also been reported, as also an eruption on the skin, said to resemble that of scarlatina.

The symptoms rarely show themselves till two or three hours, or even more, after swallowing the poison; but in some instances they have set in within half an hour. The fatal cases bear but a small proportion to cases of recovery. Death, when it occurs, takes place within twenty-four hours. In one case it happened in fifteen, in another in twelve hours. Favourable cases often last for two or three days or more; and some of the leading symptoms, such as impaired vision, and greatly dilated pupil, survive the recovery of the patient.

Delirium is generally a very marked symptom. It is sometimes pleasing, sometimes accompanied by uncontrollable laughter, sometimes by incessant talking, sometimes only by motions of the lips, the voice being lost; uniformly by spectral illusions. In some instances the state of the patient closely resembles somnambulism, in others intoxication. He is generally unconscious, and, on recovery, does not recollect what has happened to him. The delirium commonly precedes the sopor or coma; but sometimes the order is reversed, or the two states alternate. *Trismus* and *subsultus tendinum* are recorded among the nervous symptoms of occasional occurrence. In some instances the symptoms have borne a certain resemblance to those of hydrophobia.

The *vision* is affected, synchronously with the extreme dilatation of the pupil, with indistinctness, double vision, or utter insensibility of the retina.

Post-mortem Appearances.—These are by no means strongly

marked or characteristic. The vessels of the brain are congested, and there are red patches in the pharynx and œsophagus, and at the cardiac end of the stomach. The mucous membrane has been found of a dark purple colour throughout, or in patches, and portions of the berries and some of the seeds have been detected in the intestinal canal or in the stools.

Treatment.—After the prompt use of emetics, animal charcoal diffused through water, or diluted liquor potassæ, and after an interval, a full dose of castor oil. In other respects it will be determined by the symptoms actually present. Bleeding may be practised with advantage.

The *diagnosis* of the poisoning is not free from difficulty, inasmuch as similar symptoms are present in poisoning by hyoscyamus and stramonium. It is only the discovery of some portion of the plant itself in the substances rejected from the stomach, or passed from the bowels; or, in a fatal event, in the contents of the alimentary canal, that will enable us to state with confidence what poison has been taken. In many instances the description given of the part of the plant swallowed is quite decisive. The berry is easy to recognise. It happens fortunately that the active principle atropia is eliminated from the kidneys and can be detected in the urine by its action on the pupil. Dr. John Harley has repeatedly proved the presence of atropia in the urine by this means within twenty minutes of the injection under the skin of $\frac{1}{48}$ or $\frac{1}{96}$ grain of the sulphate. Twelve drops out of eight ounces of urine secreted in $2\frac{1}{2}$ hours that a patient is under the influence of $\frac{1}{48}$ grain will largely dilate the pupil, and maintain it in that state for several hours. One or two drops of urine are to be introduced between the eyelids every quarter of an hour till the effect is produced.*

Atropia (*Atropine*).—This alkaloid, when pure, is in the form of white silky crystals, which, when viewed under the microscope, are four-sided prisms. It belongs to the group of alkaloids which does not change colour when treated with cold sulphuric acid. It also undergoes no change when the acid is warmed, but assumes a deep brown tint when heated. Its colour is not changed by nitric acid. When heated on porcelain it melts easily into a pale liquid, yields a vapour which has an odour as of singed wool, and leaves a light brown stain. It melts at the low temperature of 150° Fahr., and sublimes at 280°. The sublimate is crystalline, but less constant and characteristic than those of strychnia and morphia. It is soluble in water, alcohol, ether, chloroform,

* This statement is made on the authority of a communication to the author by Dr. Harley.

and benzole: also in dilute acids, with which it forms crystallizable salts. With liquid reagents it yields few characteristic precipitates. With carbazotic acid and chloride of gold it yields abundant precipitates, which assume respectively the forms of beautiful clusters of plates, and distinct foliated groups.*

II. HYOSCYAMUS (*Hyoscyamus Niger*, *Henbane*).

This, too, is a plant of the Linnæan class and order *Pentandria Monogynia*, and of the natural order *Solanaceæ*. It is indigenous, and grows on poor waste lands, and on the sea-shore. Fig. 112 shows a cutting of the plant, a flower, and a seed-vessel. All parts of the plant are poisonous; and the seeds, root, leaves, and young shoots have severally been taken as poisons.

Fig. 112.

The poisonous property of the plant is attributed to an alkaloid, *hyoscyamia*, and a peculiar volatile principle.

The leaves are in the British Pharmacopœia, and furnish two preparations—an *extract* and a *tincture*.

The several parts of the plant are easily recognised. The *seeds* are about the size and shape of those of belladonna, but less rounded; about an eighteenth of an inch in diameter, and weighing 120 to the grain. They are thickly covered with ridges formed of nipple-like projections, marked with black lines, as shown in fig. 113, which represents the seeds of their usual size, and as seen under a low power of the microscope, with a small section more magnified. The *root* is spindle-shaped, and bears some resemblance to a small parsnep, for which it has been eaten by mistake. It also somewhat resembles the wild

Fig. 113.

* Wormley, Pl. xiii. figs. 1 and 2.

chicory. The *leaves* sessile, and half embracing the stem, are of a pale dull green colour, slightly pubescent, with long hairs upon the midrib, unequally cut at the sides and pointed at the end. The entire plant has a strong and unpleasant odour, a mucilaginous and slightly acrid taste, and a clammy feel. The plant, and its officinal preparations, vary greatly in activity and strength, according to season of the year and mode of preparation.

Effect on Animals.—Purely narcotic; no local symptoms. Very marked dilatation of the pupils.

Symptoms in Man.—These appear in from a few minutes to half an hour. They consist of flushing of the face, giddiness, rapid pulse, weakness, and trembling of the limbs, convulsive or tetanic movements, delirium (commonly of the active or violent kind), the delirium terminating in coma, or alternating with it, incoherence, loss of speech, great dilatation of the pupil, and indistinctness of vision, or total loss of sight. Heat and dryness of the throat, vomiting and diarrhœa, and a cutaneous rash are occasionally present.

As the poison (either leaf or root) has generally been taken by mistake for some wholesome vegetable, and cooked as an article of diet, we are best acquainted with the symptoms as affecting several persons simultaneously.

The most characteristic symptoms are *delirium* and *dilated pupil.* This is caused by the application to the eye of the preparations of henbane.

Post-mortem appearances.—Congestion of the brain and lungs.

Treatment.—That of poisoning by belladonna.

Poisonous effects have arisen from a poultice of the leaves applied to the abdomen, and from a decoction used as a clyster.

Hyoscyamia (*Hyoscyamine*).—M. Stas appears to have succeeded in obtaining this alkaloid; but the best manufacturing chemists, and notably Mr. Morson, have been unsuccessful. It is said to consist of white silky crystals, but generally to be amorphous; to be without odour when pure; but, as generally procured, to have a very disagreeable odour, like that of tobacco, and an acrid taste. A specimen kindly sent to me by Dr. John Harley is a pale, rose-coloured, deliquescent extract, little changed by sulphuric acid, but turned to a red-brown when the acid solution is warmed. Heated on porcelain, it darkens, smokes, and yields a bulky black ash; and a sublimate containing numerous delicate feathered crystals. Dr. Harley finds that it quickly passes into the urine, from which it may be separated by shaking it with chloroform, and identified by its action on the pupil.

III. STRAMONIUM (*Datura Stramonium, Thorn-Apple*).

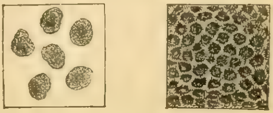
This also is a plant of the Linnæan class and order *Pentandria Monogynia*, and natural order *Solanaceæ;* growing in waste places and on dung-heaps in all parts of Europe. The annexed figure shows a cutting of the plant with sections of the flower and fruit. Every part of it is poisonous; but the fruit and seeds are believed to be the most active. The vapour of the flowers is asserted to have produced poisonous effects. In France and Germany, as also in India, and the Eastern Archipelago, the seeds of this or of other species are given to facilitate the commission of crime. Cases of poisoning by the leaves, fruit, seeds, and extract are on record; and dangerous symptoms have been occasioned by their external application. It is smoked with or without tobacco as a remedy for asthma.

Fig. 114.

The leaves and seeds are in the British Pharmacopœia, and the seeds supply an extract and a tincture.

Stramonium owes its poisonous properties to an alkaloid, known as *daturia.* The entire plant has a rank odour. The flowers, however, are sweet-scented. The *leaves* are of a dull green colour large, sharply and irregularly cut at the edges, smooth, ribbed, and veined. The *fruit,* or apple, the size of a walnut, has a strong prickly outer coat. The *seeds* are light brown or black, circular or kidney-shaped, flattened, with a corrugated surface. They are much larger than those of henbane or belladonna; for while the seeds of henbane weigh 120, and those of belladonna 90 to the grain, there are only about eight stramonium seeds in one grain. The size, and the microscopical appearance of the cuticle of the seeds, are shown in fig. 115.

Fig. 115.



The *effects of this poison on animals* are not characteristic. In common with henbane and deadly nightshade it largely dilates the pupil.

The *symptoms* of poisoning by stramonium, in the *human subject*, nearly resemble those of poisoning by henbane and the deadly nightshade. There are dryness of the throat, flushing of the face, dilated pupils, delirium, with spectral illusions, accompanied by convulsions and followed by coma, and, in some instances, irritation of the alimentary canal.

The symptoms set in very soon, and seem to be more severe than those of poisoning either by henbane or deadly nightshade. Delirium may be present in fifteen minutes, and death take place in seven hours.

Post-mortem Appearances.—In some cases congestion of the vessels of the brain, and in one instance redness of the cardiac end of the stomach.

The *treatment* consists in the prompt use of emetics, followed by full doses of castor oil; and where there is much flushing of the face, the abstraction of blood from the arm, or by leeches to the temple. In one case reported in 'Rust's Magazine,' bleeding appears to have afforded great relief, and would seem to be equally applicable in poisoning by henbane and deadly nightshade, and in cases of poisoning generally where the face is flushed and the eyes prominent and brilliant.

Daturia.—This alkaloid is believed to differ very little in its composition and properties from atropia; like it, it is found in silky crystals, which are four-sided prisms. It produces the same effect on the pupil of the eye as the alkaloids atropia and hyoscyamia.

The *diagnosis* of poisoning by stramonium is only possible by the history of the case, or by the discovery of portions of the plant in the alimentary canal, or in the matters vomited or purged.

IV. SOLANUM NIGRUM (*Black, or Garden Nightshade*).

This is an annual plant, common in gardens, by roadsides, and near manure-heaps, growing to a height of one or two feet, and bearing small white flowers, and berries which, when ripe, are black. Fig. 116 shows a cutting of the plant, with flowers and berries. The berries and leaves of this plant have been eaten by children, and have given rise to symptoms allied to those of the three poisons placed at the head of this chapter—symptoms of intestinal irritation (nausea, vomiting, colic pains, and intense thirst), and cerebral symptoms (delirium, restlessness, convulsions, tetanic spasms, and extreme dilatation of the pupil).

Fig. 116.

The symptoms produced by the leaves are well described in two cases cited by Tardieu from M. Magne, who ascertained beyond doubt that they were the leaves of the solanum nigrum.

At some time between 5 and 7 P.M., two children, 3½ years of age, ate the leaves, and about eight o'clock began to show symptoms of poisoning. In the child who died they were as follows:—Pain in the belly, gradually increasing, and attended by nausea without vomiting, then restlessness followed by delirium. These symptoms increased until towards midnight, when the child was so restless and delirious as to be with difficulty kept in bed. When seen by M. Magne, he found the belly greatly distended, the pulse very quick and scarcely perceptible, the respiration hurried, the face pale, and the pupil enormously dilated. The limbs were convulsed, the child became insensible, and sank about twelve hours after taking the poison. The child who recovered passed the whole night restless, frightened, and sleepless, and troubled with illusions. When seen by M. Magne she was asleep, with natural pulse and respiration; but on the second visit was awake and sitting up in bed, her face expressive of astonishment and fright, her pupils dilated to the utmost and fixed; but she soon began to recognise her parents, fell into a deep but disturbed sleep, and recovered in about twenty-four hours. The pupils still continued dilated.

V. SOLANUM DULCAMARA (*Woody Nightshade* or *Bitter-sweet*).

This is one of the most common plants of our hedges and roadsides. It grows to many feet in length, twisting among the branches of trees, begins to flower in June, and continues to produce flowers and berries till late in autumn. Its purple petals

with rich yellow stamens, and bright red berries, make this plant one of the ornaments of our hedge-rows (Fig. 117).

Fig. 117.

The red berries of this plant do not appear to possess the active properties of the black berries of the solanum nigrum, though they prove more attractive to children, and have been more frequently swallowed. They proved fatal to a boy, four years of age, while two older sisters, who ate them at the same time, suffered slightly or not at all. The symptoms in this fatal case were vomiting and purging, convulsions, and insensibility alternating with each other, and death in convulsions.* The evidence as to the poisonous properties of the berries of this plant, and their degree of activity, is very conflicting, and the case just cited is not free from the suspicion that some of the black berries of the solanum nigrum were eaten at the same time.

VI. SOLANUM TUBEROSUM (*the Potato*).

The berries of this plant, as well as the young shoots, possess poisonous properties, and the berries have proved fatal, as in the case of a young lady æt. 14, reported by Mr. Morris, of Merford.† There was great restlessness and jactitation, and an anxious expression; the skin was livid and covered with a cold, clammy perspiration, the respiration hurried, the pulse very quick and weak, the jaws contracted, the speech lost, the tongue covered with a dark brown moist fur; and the patient constantly spat a viscid froth through the closed teeth. She died on the second day.

SOLANIA (*Solanine*).—This alkaloid, not being used as a medicine or poison, is chiefly interesting as the active principle of the solanum nigrum and dulcamara, and of the potato, from the berries and young shoots of which it is obtained. It is sold as a white powder; but may be extracted in the form of delicate acicular crystals. It belongs to the group of alkaloids which is changed in colour by cold sulphuric acid. It assumes, with this reagent, a bright yellow tint, changing to brown when warmed, and assuming a deeper tint of brown when heated. It is not changed in colour by nitric acid. When heated on

* 'Lancet,' June 28, 1856, p. 715.
† 'British Medical Journal,' 1859, p. 719.

porcelain, it discolours, melts slowly, gives off a dense vapour which has the odour of baked apples, and swells into an abundant carbon. It sublimes at 420° Fahr., and deposits on the glass disk the characteristic long needles, variously crossed and interlaced, shown in the annexed figure. It is sparingly soluble in water, but soluble in acids. It is soluble in alcohol, but insoluble or but sparingly soluble in benzole, ether, chloroform, and amylic-alcohol. Its liquid reactions are mostly of a negative character: it yields no precipitate with most of the reagents that give abundant and often characteristic crystals with several other alkaloids. From its alcoholic solution, and as sulphate, it is deposited as delicate needles, crossed and interlaced, or radiating from a point.*

Fig. 118.

× 50.

VII. CAMPHOR.

This substance is decidedly poisonous, but has only proved fatal in one instance.

Properties.—It is a colourless, translucent, and semi-crystalline substance of a tough texture, strong and peculiar odour, and pungent and yet cool taste. It floats on water, in which it is sparingly soluble, evaporates at common temperatures, and is deposited on cool surfaces (as on the inside of bottles) in crystals. It is readily dissolved by alcohol, ether, and chloroform, and by the volatile and fixed oils. It imparts its peculiar odour to the breath.

When taken as a poison it is usually in fragments, and being sparingly soluble in the contents of the stomach, would be easily identified. If dissolved in spirits, it may be separated by distillation, and thrown down by the addition of water.

The *symptoms* of poisoning by camphor begin with languor, giddiness, dimness of vision, and confusion of intellect, followed by depression, intoxication, or violent delirium. Convulsions also occur, especially in children; and there is much excitement of the circulation, with heat of skin, flushed face, hurried pulse, and dilated pupil. Recovery takes place after a long, deep sleep.

Mr. J. C. Bellamy, of Plymouth, communicated to me the following account of the effect on himself of twenty grains of camphor dissolved in spirit. Giddiness came on almost immediately, he fell into a chair, had a series of fits of uncontrollable

* Wormley, Pl. xiii. figs. 5 and 6.

laughter, followed by extreme faintness and cramps. Then ensued nearly complete paralysis, the voice being reduced to the faintest whisper. This state continued several hours, and left behind it great debility. The mind was not affected.

The *post-mortem appearances*, as observed in animals, are inflammation of the stomach and bowels, injection of the membranes of the brain, and inflammation of the urinary passages. The odour of the poison pervades the whole body.

The *smallest fatal dose* has not been ascertained. Twenty grains have produced serious symptoms in an adult male, and thirty grains have proved fatal to an infant eighteen months old, in seven hours.

The *treatment* consists in the prompt use of emetics, followed by castor oil as a purgative. The discharge of the contents of the stomach is generally followed by speedy relief.

VIII. ŒNANTHE CROCATA (*Hemlock Water Dropwort*).

Fig. 119.

This is an indigenous umbelliferous plant, growing on the banks of streams and ditches, and bearing some resemblance to celery (fig. 119). All parts of it are poisonous; but the root, from a rough resemblance to the parsnep, is generally the part eaten by mistake; and is so virulent a poison that a very small piece of it has proved rapidly fatal.

The *symptoms* may set in as soon as twenty minutes after swallowing the poison, with convulsions and insensibility, livid bloated face, mouth and nostrils covered with bloody foam, and stertorous respiration; and death may follow in as little as five minutes from the first seizure. In more protracted cases severe nervous symptoms show themselves, consisting of locked jaw, tetanic spasms, and violent mania, or delirium allied to delirium tremens. The pupil is usually dilated. There are symptoms of violent irritation in the alimentary canal.

The *post-mortem appearances* consist of great congestion of the brain; an accumulation of dark blood in the lungs, heart, and large vessels; and signs of irritation in the stomach and bowels.

The *treatment* consists in the prompt use of emetics, followed by a full dose of castor oil. Bleeding is indicated by the congested state of the cerebral vessels. The rest of the treatment will be determined by the symptoms actually present.

IX. COCCULUS INDICUS (*Levant Nut*).

This is the berry of a plant known as the Menispermum, or Anamirta Cocculus. It has the size, shape, and section shown in fig. 120. The shell acts as an emetic, while the seed itself contains an active poison (Picrotoxia), in the proportion of from 1 to 2 per cent. An extract of the berries is sold for poisoning fish, to the flesh of which, when used in large quantity, it imparts a poisonous property; and a decoction or extract is employed to give an intoxicating quality to ale, porter, and spirits. It is used with this intent by thieves. In two instances, at least, the poison has proved fatal in the human subject.

Fig. 120.

The *symptoms* are those of severe irritation in the alimentary canal, with delirium, and "a lethargic stupor, with a consciousness of passing events, but a complete loss of voluntary power."

PICROTOXIA (*Picrotoxine*).—This poison consists of colourless prismatic crystals, which have an intensely bitter taste. It belongs to the group of active principles which does not change colour with cold sulphuric acid; but the acid solution becomes yellowish when warmed, and brown when heated. Nitric acid dissolves it without change of colour. When heated on porcelain it melts, darkens, effervesces, gives off vapour, forms large bubbles which break, and leaves a moderately abundant carbon. It melts and sublimes at 320° Fahr., but the sublimate is not characteristic. An alkaline solution, with addition of sulphate of copper, when heated, deposits the oxide of copper. The crystals are soluble in 150 parts of cold water, and are readily dissolved in alcohol, ether, chloroform, and fusel oil. They are also sparingly soluble in acids, but soluble in solutions of potash and soda. From organic liquids, such as beer and porter, picrotoxia may be readily obtained by first acidulating with hydrochloric acid, and then shaking the liquid with ether which holds the poison in solution, and deposits it as crystals. This method has been practised with success by Mr. Langley.*

* 'Pharmaceutical Journal,' 1862, p. 277.

X. LOLIUM TEMULENTUM (*Darnel*).

Fig. 121.

The seeds of this plant are sometimes mixed with other grains, used for distillation, or ground into flour for making bread. When so used they may produce marked symptoms of poisoning, including heat of throat, headache, giddiness, staggering as if from intoxication, strong tremulous movements of the limbs, impaired vision, symptoms of collapse, and vomiting. The annexed engraving shows a cutting of the plant, with an enlarged flower (*c*) and vertical section of the seed (*e*).

XI. POISONOUS FUNGI.

The fungi constitute a large class of plants, of which some are eaten with impunity, except by a few persons of peculiar constitution; and many more habitually eaten on the Continent, are now recommended for use in England; while others at least as numerous are esteemed, or known to be, poisonous.

The *symptoms* of poisoning by fungi are very variable in the time at which they appear; sometimes coming on soon after eating them, in other cases, after an interval of some hours, and even as late as twenty-four, or even thirty-six, hours. Nor are the symptoms always developed in the same order, for symptoms of irritation of the alimentary canal sometimes precede the nervous symptoms, sometimes follow them; and in the same group of cases, some will suffer from intestinal irritation, others from nervous symptoms. The symptoms of irritation consist of constriction of the throat, nausea, heat and pain of stomach, painful retchings, and vomiting with or without purging; and the nervous symptoms of headache, giddiness, dimness of sight, illusions of the senses, delirium, and coma. One poisonous fungus (amanita muscaria) appears to produce the pleasing intoxication of the laughing gas.

In the case of the most poisonous fungi, the symptoms often run a rapid course, without intermission or relief, and death may take place within twenty-four hours.

The *post-mortem appearances* consist in inflammation and its consequences in the stomach and bowels, and of congestion of the brain with softening of parts of it.

The *treatment* consists in the prompt use of emetics of common salt, followed by a full dose of castor oil, and the free exhibition of mucilaginous drinks.

Diagnosis.—The distinction of poisonous and esculent fungi is not so easy as might be wished. With the exception of the common field mushroom (*agaricus campestris*) and of the puff-ball (*lycoperdon giganteum*) in its early growth, while presenting a compact white texture throughout, there are few, if any, edible fungi which the common people can be trusted to distinguish from poisonous ones. Even when the two kinds are contrasted in charts faithfully drawn and coloured, some care is needed to distinguish one or two of the species from others which resemble them. Nor can the general rules that have been laid down for the distinction of the one class from the other be depended on. The vulgar test of the silver spoon, which is supposed to be discoloured when boiled with poisonous fungi, is quite useless; though it may serve to indicate decomposition, and the formation of sulphuretted hydrogen. The following general precautions may, however, be observed with advantage:—Rejecting, to begin with, all fungi that have an eminently offensive and repulsive odour, and those which present green or scarlet colours of unusual brilliancy, those also should be disallowed which have a bitter, styptic taste, burning and parching the throat; those also that have a livid hue, and assume various colours when broken or bruised; those again which rapidly deliquesce, or yield a "spiced milk" of whatever hue, and whether changing colour or not. These rules should be observed by the ignorant, and not be broken without caution by the better informed.* In the cooking of fungi the free use of salt and vinegar is recommended. Some volatile poisonous matters are also dispelled at the boiling temperature. It may be well to add that wholesome fungi have been rejected through prejudice, and the occasional production of symptoms of indigestion by stale fungi, or by those which unite a compact texture with the presence of nitrogen, as in animal

* Reference may be made to the scientific and learned treatises of Berkeley and Badham ('Outlines of British Fungology,' and the 'Esculent Fungi of England'), to the more popular work of M. C. Cooke, and the coloured charts, with explanations, by W. G. Smith.

matters. The common mushroom, so largely eaten in England, is rejected in Italy.

The peculiar microscopic structure of the cellular tissue, and spores of the fungi, whether wholesome or poisonous, may enable us to ascertain by an examination of the contents of the stomach, or vomited matters, that some fungus has been taken with the food.

The annexed illustrations, after larger drawings given by Tardieu, on the authority of M. E. Bondier, show these characteris-

Fig. 122.

1. 2. 3.

tic structures. Fig. 122, 1, shows the cellular tissue of the *pilens* of the amanita bulbosa; 2, shows the same tissue after cooking; 3. the *hymenium* and sub-hymenial tissue of the same, with the *bassidia* surrounded by four *stigmata* bearing spores.

Fig. 123 shows the spores of the Russula emetica, 1; those of

Fig. 123.

1. 2. 3. 4.

the amanita bulbosa, 2; those of the lactarius deliciosus, 3; and the ripe spores of the agaricus campestris, or common mushroom, 4.

CHAPTER XI.

INEBRIANTS.

I. ALCOHOL. II. ETHER. III. CHLOROFORM.

COAL NAPHTHA, BENZOLE, NITROBENZOLE, ANILINE, AND CARBOLIC ACID. WOOD NAPHTHA, OIL OF TURPENTINE, KREASOTE, AMYLENE, AND AMYLIC ALCOHOL. NITRO-GLYCERINE. DIPPEL'S OIL.

THE poisons alcohol, ether, and chloroform, have the common property of inducing a state of narcotism, often preceded by delirious excitement, and followed by indisposition, of which nausea and vomiting are generally the leading symptoms. In large doses, and in a concentrated form, they may destroy life suddenly by shock; but they generally prove fatal by inducing a state allied to apoplexy, or by paralysing the heart. They act as irritants to the parts with which they come in contact, producing intense inflammation in the lining membrane of the stomach when swallowed, and in the lining membranes of the air-passages when inhaled. But they do not affect the whole tract of the intestinal canal, as do the poisons belonging to the class of irritants.

All the poisons of this group are more or less volatile, and their vapours, when inhaled, act more powerfully than like quantities of the liquids themselves when swallowed. The employment of ether and chloroform as anæsthetics gives them a special importance.

I. ALCOHOL.

Alcohol, or spirit of wine, is the active ingredient of a great variety of intoxicating agents obtained from saccharine juices in a state of fermentation. By the distillation of such fluids, followed by rectification with charcoal, and a final distillation from quick-lime, *anhydrous* or *absolute* alcohol is obtained. This, diluted with 16 per cent. of water, constitutes rectified spirit, and with little more than its weight of water, *proof spirit*. This differs little in strength from the various *ardent* spirits distilled

from wine, malt, molasses, or rice, flavoured and coloured with burnt sugar, juniper berries, and peat, and known respectively as brandy, whisky, hollands or gin, rum, and arrack. The absolute alcohol in these ardent spirits varies from 51 to 54 per cent. Of the stronger wines it constitutes from 12 to 17, of the lighter wines from 7 to 9, and of the stronger English malt liquors from 5 to 6 per cent.

Properties.—Pure alcohol is a colourless, volatile liquid of low specific gravity (0·795), boiling at 173°, and not freezing at the lowest attainable temperature. It has a pleasant odour, and a burning, pungent taste, is very inflammable, burns with a light-blue flame, and yields, as the products of its combustion, carbonic acid and water.

Tests.—*a.* When burned, it leaves no stain of charcoal. *b.* The products of combustion render lime-water or the solution of nitrate of baryta white and turbid. *c.* It dissolves camphor. *d.* To a drop of alcohol add dilute sulphuric acid, and a drop of a solution of bichromate of potash, and apply the heat of a spirit-lamp. The orange-coloured solution is changed to green by the liberation of oxide of chromium, and the fruity odour of *aldehyd* is perceived at the mouth of the tube.

In Organic Liquids.—The contents of the stomach in persons killed by large doses of spirituous liquors generally have the odour of the spirit. If they contain any spirit it may be separated by the same process of distillation as is adopted to obtain anhydrous or absolute alcohol from fermenting saccharine substances. If they have an acid reaction, they must first be neutralized by potash. The liquid resulting from the distillation may be identified by the tests just enumerated applied as follows:—Dip a glass rod into the distilled liquid, and see if it burns. Apply the chrome-test as above. If these tests fail, place the liquid in a tube, and add dry carbonate of potash as long as it dissolves. The water will be taken up by the carbonate of potash, and the alcohol will rise to the surface. Draw this off with the pipette, and repeat the tests.

Alcohol is absorbed, and may be detected by its odour, and by tests applied to the products of distillation, in the blood and secretions, in the brain, and in other solid viscera.

Experiments on Animals.—From Sir Benjamin Brodie's experiments on rabbits with large quantities of proof spirit, it appears that symptoms of poisoning set in immediately or in a few minutes, and that death ensues in about from half an hour to an hour and a quarter. In one experiment two ounces of proof spirit were injected into the stomach of a rabbit, and the injection

was scarcely completed when the animal became perfectly insensible. It appeared dead in twenty-seven minutes, but the heart had not ceased to beat. The symptoms produced were complete insensibility, dilatation of the pupils, rapid pulse, laborious and stertorous breathing, and slight convulsions. The lining membrane of the stomach bore marks of acute inflammation.

SYMPTOMS, MORBID APPEARANCES, AND TREATMENT.

Symptoms.—After a period varying from a few minutes to an hour or more, according to the quantity and strength of the alcoholic liquid—a period during which there is often an agreeable physical and intellectual excitement—the symptoms set in with confusion of thought, headache, giddiness, imperfect or double vision, indistinct and stammering speech, uncertain and abrupt movements of the limbs, and a tottering and stumbling gait. At length the patient becomes speechless, motionless, and insensible, with a bloated and suffused countenance, injected eye, dilated and fixed pupil, livid lip, and slow stertorous breathing. Recovery may take place after a prolonged sleep, attended with profuse perspiration, or more abruptly by vomiting; or death may occur after an interval of several hours with symptoms of collapse, indicated by pallor of the face, cold sweats, quick and feeble pulse, involuntary evacuations, and complete relaxation of the limbs. Very large quantities of ardent spirits kill almost instantaneously by shock. Insensibility either sets in suddenly, or as a relapse after apparent recovery. Convulsions are among the occasional symptoms, and delirium tremens and raging incoherence are sometimes the result of a single debauch. Sir Benjamin Brodie has shown that the symptoms of poisoning by alcohol nearly resemble those of concussion of the brain: they are also difficult to distinguish from the effects of severe cold and from those of poisoning by opium. In many cases the odour of spirits assists the diagnosis; and as a general rule, the pupils are dilated in poisoning by alcohol, and contracted in poisoning by opium, and the countenance which is flushed in the one case is pallid in the other.

Post-mortem Appearances.—The most constant appearance is a deep crimson or dusky red colour of the lining membrane of the stomach, sometimes extending upwards to the gullet and downwards to the commencement of the small intestines. In some cases there is dark extravasation under the lining membrane; in others the stomach is inflamed only in patches; in others, again, there are no marks of inflammation in any part of the organ.

Congestion of the brain, and of the air-passages, are among the less constant appearances.

Treatment.—The stomach-pump should be used without delay, and the cold affusion as a shock. The after-treatment will depend on the state of the patient. If there is much congestion of the brain, blood may be drawn from the arm. If great difficulty of breathing, with a cold surface and feeble pulse, the treatment proper to apnœa may be required. In the last resort, galvanism may be employed.

Chronic Poisoning by Alcohol.—Drunkards suffer from functional and organic diseases of all the important organs of the economy: from indigestion, with vomiting and purging, through irritation of the stomach and bowels; from jaundice, through irritation of the liver; from albuminous urine, diabetes, and other urinary disorders, through irritation of the kidney; from congestion of the brain, delirium tremens, and insanity, paralysis, convulsions, and shaking palsy; as the effect of the poison on the nervous centres. The organic diseases induced by the prolonged abuse of spirituous liquors are fatty degeneration of the liver, kidneys, heart, brain, and spinal cord, scirrhus of the stomach, and pulmonary consumption. Dropsy is a common result of the organic diseases of the drunkard.

II. ETHER.

Several volatile and inflammable liquids are known under the general name of *ether*, and they are divided into the three groups of simple, double, and compound ethers. The liquid known as ether, ordinary, vinic, or sulphuric ether, belongs to the first group, and is the poison here spoken of. It is the product of the distillation of a mixture of alcohol and sulphuric acid.

Properties.—Pure ether is a limpid, colourless liquid, highly volatile and inflammable, with a specific gravity of 0·735°, boiling at 95°, and freezing at about −24°. It evaporates without residue, burns with a yellow flame, and deposits charcoal on cooled surfaces, but when burned with a proper proportion of oxygen is resolved (like alcohol) into carbonic acid and water. It yields a dense, inflammable vapour, which forms with oxygen or air, in certain proportions, an explosive mixture. Its odour is penetrating and characteristic, and its taste hot and pungent, but in evaporating it gives a sensation of cold. It is sparingly soluble in water, but freely in alcohol. It is also a powerful solvent of several bodies, among others iodine, corrosive sublimate, and certain of the alkaloids.

Tests.—*a.* Its characteristic odour. *b.* Its imperfect com-

bustion, leaving a stain of carbon on cool surfaces. *c.* Its partial solubility in water, the bulk of the liquid floating on the surface. *d.* It has the same reaction as alcohol with bichromate of potash and sulphuric acid.

In Organic Liquids.—Ether is separable from the contents of the stomach by the same process of distillation as alcohol.

Experiments on Animals.—The experiments of Orfila show that ether produces nearly the same effect on animals as alcohol.

SYMPTOMS, MORBID APPEARANCES, AND TREATMENT.

Symptoms.—Large doses of liquid ether, such as several drachms, give rise to nearly the same effects as alcohol. A stage of delirious excitement is followed by narcotic symptoms.

The symptoms which follow the inhalation of the vapour show themselves more quickly, and are more severe than those that follow the swallowing of an equal quantity of the poison. The first effects are seen in quickened pulse and respiration, flushed face, suffused eye, and mental excitement; but if the inhalation be continued, the patient falls into a state of stupor, with slow laborious stertorous breathing, and quick pulse. The face and lips are livid, the surface pale and cold, the pupil dilated and fixed, the eye turned upwards, and the whole voluntary muscular system relaxed. If the inhalation is carried on for a few minutes only, these symptoms soon disappear; but if it is continued for ten minutes, a quarter of an hour, or more, all the effects are increased, and the patient is roused with difficulty. When the effect of the poison is complete, sensation is suspended, so that long and difficult operations may be performed either without any evidence of pain, or with indications of suffering which leave no recollection behind them. But the symptoms do not always conform to this description. The poison sometimes causes violent excitement; in other cases, a state of incoherence; in others, again, a troublesome cough; and nausea and vomiting either occur during the inhalation, or they are among the symptoms of recovery. The prolonged inhalation of the vapour may end fatally.

Post-mortem Appearances.—Those due to poisoning by alcohol. The odour of ether perceptible in the contents of the stomach, and throughout the body.

Treatment.—That of poisoning by alcohol.

III. CHLOROFORM.

Chloroform, or chloroformyl is one of the large class of chemical compounds formed by substituting chlorine, bromine, or iodine for the hydrogen of the simple or compound ethers. It is obtained

by distillation from a mixture of slaked and chlorinated lime, rectified spirit, and water.

Properties.—Chloroform is a colourless liquid, of high refractive power, and high specific gravity (1·497), very volatile, giving off a dense vapour, and boiling at 142° F. It has a sweet pungent taste, and a strong pleasant odour compared to that of apples. It is perfectly soluble in alcohol and ether, but very sparingly so in water, in which it sinks in large globules. If pure it has a neutral reaction, does not discolour oil of vitriol, has no odour of chlorine, and leaves no unpleasant odour on evaporation. It dissolves camphor, volatile oils, wax, resin, caoutchouc, gutta percha; iodine, bromine, sulphur, and phosphorus; and some of the alkaloids, among which strychnine is the most important. At a red heat its vapour is resolved into chlorine and hydrochloric acid.

Tests.—*a.* Its taste and odour. *b.* Its high specific gravity and sparing solubility in water. *c.* It is not easily inflamed, and burns with a green flame. *d.* It completely dissolves camphor, gutta percha, and caoutchouc. *e.* It produces its characteristic effects on small animals.

In Organic Mixtures.—Liquid chloroform may be separated from the contents of the stomach by distillation at 120° F. The vapour may be separated from the blood and tissues by the same process, or by one based on the fact that, when transmitted through a tube heated to redness, it is decomposed and resolved into chlorine, hydrochloric acid, and carbon. The method of procedure is very simple. The organic matter is put into a flask with a narrow tube bent at right angles. On heating the mixture to a temperature of about 150°, the chloroform is volatilized, and on heating the tube with the flame of the spirit-lamp is decomposed. The vapours that issue from the open end of the tube, if received on paper moistened with solution of iodide of potassium and starch, develope the characteristic blue colour; if received on a glass plate moistened with a solution of nitrate of silver, the chloride of silver is formed; while moistened litmus paper is first reddened and then bleached.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those due to poisoning by ether, but they set in more rapidly. The loss of sensibility is more complete, and the relaxation of the muscular system may extend to the sphincters. Death may take place suddenly from shock or syncope, in convulsions, or in an epileptic fit; and the fatal event may happen either during the inhalation, immediately after it, or at an interval of several hours, or even at the end of one or two days. Among the fatal cases there are many in which it is not possible

to attribute the event to the impurity of the chloroform, or to want of skill and care in administering it. Death has been due in some cases to disease of the heart or brain; in others, probably, to the action of the poison combined with the shock of the operation. The depressing effect of chloroform vapour has its appropriate antidote in the excitement produced by the inhalation of ether; so that the practice of combining the two vapours in equal quantities is to be commended.

Chloroform may be said to give rise to five successive effects:—1. Exhilaration. 2. Drunken drowsiness. 3. Profound sleep, with contracted pupil. 4. Perfect insensibility. 5. Coma, with slow breathing and dilated pupil. (Druitt.)

Fatal Period.—Death may take place in less than two minutes from the commencement of the inhalation.

Fatal Dose.—The vapour from fifteen drops of chloroform has proved speedily fatal. A drachm of liquid chloroform swallowed by a boy four years old, proved fatal in three hours.* For a minute detail of the symptoms and post-mortem appearances in a case of poisoning by repeated doses of liquid chloroform, amounting in the aggregate to more than five ounces, consult the case of Dr. Glover, as described by Mr. F. J. Gant.† Death took place, in this instance, after 25 hours, in spite of judicious and persevering treatment. Consult also the able chapter on chloroform in the sixth edition of Druitt's 'Surgeon's Vade Mecum.'

Treatment.—Cold affusion as a shock, followed by the treatment proper to apnœa, the tongue being drawn forward to give more free access of air to the windpipe. In poisoning by liquid chloroform, the treatment should commence with the use of the stomach-pump.

The supplemental list which heads this chapter, roughly divided into three groups, according as they are derived from the destructive distillation of coal, wood, or animal matter, or by analogous processes, comprises some important poisons, which can only be briefly noticed, the reader being referred for fuller information to works on toxicology. Our knowledge of these poisons is sufficient to justify the position assigned to them in this classification; though there are indications that, after larger experience, some of them will have to be transferred from "inebriants" to better-defined classes.

From among these poisons some may be set aside as of little

* Taylor, 'On Poisons,' p. 740. † 'Lancet,' April 23, 1859, p. 425.

importance—*e.g.*, the vapour of *amylene*, tried as an anæsthetic, and disused after causing two deaths; and wood-naphtha and nitro-glycerine, as not likely to come into use as poisons. Others may be treated briefly on account of their being in frequent use in the practice of medicine, but though possessed of poisonous properties, rarely, if ever, destroying life—*e.g.*, oil of turpentine and kreasote; and others again, as fusel and Dippel's oil, on account of their rarity. Coal naphtha, carbolic acid, and nitro-benzine, are entitled to be more fully discussed, both as poisons that have proved fatal to the human subject, and as liquids (in common with benzole and aniline) largely used in the arts.

Oil of Turpentine.—This liquid is evidently possessed of poisonous properties, partly irritant, partly narcotic. Two drachms of the oil have killed a dog in three minutes, the effects showing themselves immediately in staggering, cries, tetanus, and failure of pulse and respiration. In the human subject it is often given as an aperient, or used as an injection, for the destruction of worms, or to promote the expulsion of flatus from the bowels. For these purposes it has been administered in doses of one, two, or three ounces, and has acted only as an aperient; but in some instances it has caused violent irritation of the urinary organs, and in others intoxication, followed by coma, collapse, and convulsions. It has more than once caused dangerous symptoms in young children, these being sometimes described as *intoxication.*

Kreasote.—This is one of the products of wood-tar. It is named from its property of preserving flesh, and possesses very powerful antiseptic properties. It is used in medicine, chiefly for the purpose of checking obstinate vomiting; but it is also employed as a local application to carious teeth, and externally, in a state of dilution, in fœtid ulcers, and in some skin diseases. If applied to the skin it destroys its vitality. It is an active poison. Thirty drops suffice to kill a rabbit in one minute. In the human subject, a large medicinal dose produces irritation of the stomach and bowels, with giddiness, headache, and drowsiness. Two drachms in a single dose have proved fatal to an adult in thirty-six hours.

Fousel or *Fusel oil* (amylic alcohol, potato-spirit, oil of grain).—This liquid, distinguished by its peculiar and disagreeable odour, burning taste, and irritating vapour, acts as an inebriant, whether swallowed or inhaled, causing headache, giddiness, and staggering gait.

Oil of Dippel.—This animal oil is the product of the destructive distillation of hartshorn, bones, and other animal matters. It has twice proved fatal in the human subject, but under cir-

cumstances which have prevented a full description being given of the symptoms occasioned by it. Vomiting was present, and, on examination of the body, there were marks of irritation of the stomach and bowels, and of strong corrosive action in the mouth and gullet.

Coal-naphtha.—This result of the distillation of coal-tar has proved fatal to a boy twelve years of age. It was taken in the large dose of three ounces, and death happened in less than three hours. The first symptoms were those of intoxication and furious delirium, soon followed by insensibility, stertorous breathing, and cold skin; then, after partial recovery, following vomiting, fresh symptoms of collapse. Four days after death the body was pervaded by the peculiar odour of the poison.*

Carbolic acid (phenic acid).—That this valuable antiseptic, now extensively used for so many sanitary purposes, would prove poisonous when swallowed in a concentrated form or in strong solution, might be inferred from the fact that oil of tar, of which it is a leading constituent, has more than once destroyed life.

Benzole or *Benzine.*—This is a limpid, colourless liquid, of low specific gravity (0·85), with a peculiar and not unpleasant odour, boiling at 177°, and giving off a highly inflammable vapour. It is not soluble in water, and being an excellent solvent for strychnia, is used to separate it from its solutions. Being also an excellent solvent of fats and oils, it is largely used for removing greasy stains. Both the liquid and its vapour possess poisonous properties.

Nitro-benzole (nitro-benzine, essence of mirbane).—This product of benzole and nitric acid is a thin oily liquid of a pale yellow tint, with a sweet taste, and an odour so nearly resembling that of bitter almonds, that it is often substituted for it in confectionery. It is also largely used under the above title of essence of mirbane, in perfumery. It is distinguished from oil of bitter almonds by strong sulphuric acid, which gives with it no change of colour, but with the oil a fine crimson. It has been shown to be a very active and fatal poison both by experiments on animals, and by several deaths in the human subject, caused by swallowing the liquid, by inhaling the vapour, or by the two combined. Dr. Letheby, in 1863, communicated to the Royal Society a very interesting paper on poisoning by this liquid and by aniline,† from which we learn that both liquid and vapour are most active and energetic, yet insidious, poisons. In animals, the poison produced either rapid coma, or paralysis and coma after a

* 'Lancet,' 1856, p. 230.
† See also the 'Pharmaceutical Journal,' August, 1863.

long period of inaction. In the human subject, the inhalation of the diluted vapours (as in manufactories of nitro-benzine and aniline) gives rise to headache and drowsiness; but when the vapour is less diluted or the poison is swallowed, there is first drowsiness, then, after a time, flushing of the face, a stupid expression, and an unsteady gait, as if from drinking, followed by increasing drowsiness, and then by coma, sudden as in a fit of apoplexy, and continuing till death. From the taking or inhaling of the poison to the coma about four hours elapse, and five hours from that till the death. After death there were flushed face, livid lip, general fulness of the vessels, the blood everywhere black and fluid, the liver of a purple colour. Dr. Letheby concludes that nitro-benzine and aniline are powerful narcotic poisons, exerting little irritant action on the stomach and bowels; sometimes acting and killing quickly, sometimes remaining inactive for a long time; that by oxidation and reduction nitro-benzine is changed in the body into aniline, and aniline (and its salts) into mauve or magenta. This latter change may occur during life on the surface of the body; and it may also take place after death. The characteristic odour and change of colour will greatly assist in identifying the poison as the cause of death. The nitro-benzine is separated by distillation from the organic matters, slightly acidulated with sulphuric acid. For a full description of the method of procedure consult the paper in the 'Pharmaceutical Journal.'

It may be observed, of all the liquids contained in this chapter, that they possess highly characteristic physical properties, and among them an odour which enables them to be easily recognised in the contents of the alimentary canal and throughout the body.

CHAPTER XII.

CONVULSIVES.

NUX VOMICA, STRYCHNIA, AND BRUCIA.

The alkaloid strychnia is the chief active ingredient in several plants that have the common property of giving rise to symptoms similar to those of tetanus. It is generally found with another alkaloid, brucia, possessed of similar, but less active, poisonous properties.

Strychnia is ascertained to be the active poisonous principle of five plants—the Strychnos nux vomica, S. Ignatia, S. tieuté, S. toxifera, and S. colubrina. A cutting of the S. nux vomica, with a section of the fruit showing the seeds, is given in fig. 124. All these are natives of hot climates. The Strychnos nux vomica grows as a tree in Coromandel, in other parts of India, and in Ceylon; the S. Ignatia in the Philippine Islands, also as a tree; the S. tieuté in Java, as a large climbing shrub; the S. toxifera is a native of Guiana; and the S. colubrina grows as a tree in many parts of Asia.

Fig. 124.

The S. nux vomica yields the poisonous seed and bark in use in this country; the S. Ignatia produces the seed known as the bean of St. Ignatius; the S. tieuté supplies the bark of which an aqueous extract constitutes the upas poison; the S. toxifera was till lately the reputed source of the poison variously designated as woorara, woorali, oorara, curare, and ticunas, used by the natives of South America in preparing their poisoned arrows. There is now reason to believe that this poison is a compound derived from several sources (animal and vegetable). The curare as thus prepared, as well as the upas antiar (from the Japanese tree the Antiaris toxicaria), and the poison nut of Madagascar (the produce of the Tanghinia venenifera) act on the heart and brain, and not on the spinal cord. For more minute details respecting these poisons, the reader is referred to works on Toxi cology.

There are three vegetable productions more or less common in England which contain strychnia—the bean of St. Ignatius, and the bark and seeds of the Strychnos nux vomica.

The *beans of St. Ignatius* are not often met with out of museums. They are the seeds of the pear-shaped fruit of the S. Ignatia, in which they exist to the number of about twenty. They vary in size from that of a nut to that of a large filbert. They have a thin brown outer coat, which is easily detached, and leaves a smooth, black surface. They are very hard, and look like small pebbles with irregular rounded outline, and two or three unequal flattened surfaces. They contain strychnia in the large proportion of 12 parts in 1000, and some brucia, and act like nux vomica or strychnia.

The *bark of the Strychnos nux vomica*, formerly mistaken for cusparia or angostura bark, and named, accordingly, "false Angostura bark," has a very characteristic appearance. It is quilled, or twisted like dried horn, and is thickly covered with white prominent spots bearing some resemblance to a lichen. It yields a light yellow powder of an intensely bitter taste, which is reddened by nitric acid. It contains both strychnia and brucia, and acts in the same manner as the seed or the alkaloid.

The nux vomica, or seed of the S. nux vomica, is much more important, and requires to be more minutely described.

NUX VOMICA.

This poisonous seed is largely imported into this country; and a spirituous extract (extractum nucis vomicæ) given in the dose of half a grain to two grains, and a tincture, containing forty-four grains to the ounce (dose ten to twenty minims)

are in the British Pharmacopœia. The nut or seed, as well as the alkaloid and its salts, are in common use as poisons for wild animals, rats, and vermin; and they are prescribed as medicines in paralytic affections, and in some other diseases to which they would seem less applicable. In the two years 1837–8, nux vomica was the cause of death in three instances.

The seeds, three to five in number, are enclosed in a rich orange-coloured fruit of the size and shape of a large apple. They are circular in outline, and vary in size and thickness from that of a shilling to that of a florin. Their edges are rounded; one surface is concave, the other convex, or convex in the centre and deeply grooved near the margin as in fig. 125. A horizontal section has the appearance shown in fig. 126, and a vertical sec-

Fig. 125.

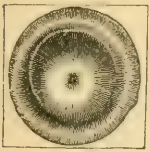
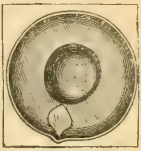


Fig. 126.

Fig. 127.



tion displays a circular central cavity and heart-shaped embryo, as in fig. 127. By introducing a sharp knife at the projecting point shown in fig. 125, the seed may be easily cleft so as to display the embryo. The seeds have an external coating of light brown silky hairs, radiating from the centre, but the bulk of the seed is white, or of a light slate colour, and has a waxy appearance. Their texture is so hard that it can only be reduced to powder by rasping or filing. When turned in the lathe they yield a white shaving. The interior of the seeds assumes a rich orange colour when touched with nitric acid, and is tinged green by the perchloride of iron.

The powder of the seeds has the colour of jalap powder, a faint odour, and an intense and persistent bitter taste. The brown silky fibres which coat the nut are seen in large numbers under the microscope, and are very distinctly defined when treated with a drop of strong nitric acid. The watery solution of the powder is rendered pink by nitric acid, and green by the perchloride of iron. The powder contains the alkaloids strychnia and brucia in union with strychnic or igasuric acid. The quantity of strychnia has been variously estimated at 4 and at 10 parts in the 1000.

The extract is readily recognised by the rich orange colour

imparted by nitric acid, the lake colour developed by sulphuric acid, and the transient blue tint given by sulphuric acid and bichromate of potash.

Symptoms.—Those of poisoning by strychnia; combined in some cases with irritation of the alimentary canal.

Commencement of Symptoms.—From five minutes to an hour, or even more, according to the form in which it is given.

Fatal Period.—From fifteen minutes to three hours or more. One hour is a common period.

Fatal Dose.—Thirty grains of the powder, the weight of a nut of medium size, and three grains of the alcoholic extract, have proved fatal.

Post-mortem Appearances.—Those of poisoning by strychnia. The brown powder often adheres to the lining membrane of the stomach.

Treatment.—The poison to be removed by emetics or the stomach-pump. The rest of the treatment that of poisoning by strychnia.

STRYCHNIA.

This alkaloid is now largely used in every part of the world to destroy wild animals and vermin. In poisoning wild animals it is usual to insert it into the stomach of a small animal or bird recently killed; and in poisoning birds, to steep grains of wheat in a strong solution of the alkaloid, or of one of its salts. A powder known as "Battle's Vermin Killer" contains, according to an analysis by Dr. Letheby, 23 per cent. of the poison mixed with flour, sugar, and Prussian blue, and "Butler's Vermin Killer" consists of strychnia mixed with flour and soot, in the lower proportion of about 5 per cent. The flesh of animals that have eaten of poisoned meat or grain sometimes proves poisonous to other animals.

Strychnia in the dose of $\frac{1}{30}$ to $\frac{1}{12}$ grain, and the liquor strychniæ containing 4 grains to the ounce, and in the dose of from 5 to 10 minims, are admitted into the British Pharmacopœia. In consequence of this twofold use of strychnia as a popular poison for animals, and as a medicine, cases of accidental poisoning sometimes occur. Of late years, too, the alkaloid has become a formidable instrument in the hands of the murderer; and is believed to have been the immediate cause of death in more than one recent instance, as in those of Palmer and Dove. On an average of the five years 1852–56 strychnia and nux vomica are credited with two deaths.

Strychnia may have to be examined—1. In substance. 2. In solution. 3. In organic mixtures.

1. *In Substance.*

Properties.—Strychnia is found in commerce both as a white powder, and as a colourless crystal. In commercial specimens the form of the crystal is a rectangular prism, either of the exact shape shown in fig. 128, or with the ends replaced by one or two oblique planes. When obtained from solutions of its salts by addition of liquor ammoniæ, or, still better, by exposure to its vapour, they present under the lens or microscope three leading forms—the long rectangular prism, the short hexagonal prism, or the regular octahedron. From a group of crystals obtained by exposing a drop of a solution of the acetate of strychnia to the vapour of ammonia, the forms shown in figs. 129 and 130 have been selected.* The crystals in fig. 129 are

Fig. 128.

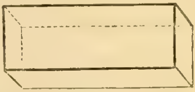


Fig. 129.

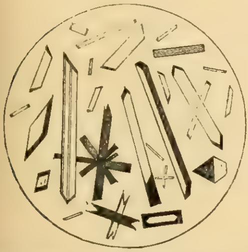
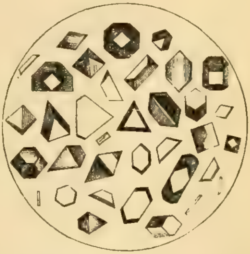


Fig. 130.



long four-sided prisms, isolated or in stellate groups, with a single octahedron shown in contact with one of the prisms. The crystals in fig. 130 are either regular octahedra or modifications of the same, or short six-sided prisms; and there are one or two dodecahedra, rhomboidal and pentagonal, as well as plates of different forms, and among them one of the deep triangular plates so common in some specimens of arsenious acid. The octahedra will be recognised in the several points of view in which they present themselves, on referring to the account given of the crystals of arsenious acid at p. 388.

Strychnia has an intensely bitter and very persistent taste, which is stated to be distinctly perceptible in solutions containing one grain of the alkaloid in a gallon (70,000 grains) of water. Strychnia is so insoluble in water as to require for its solution

* Acetate of morphia similarly treated yields prismatic forms only (fig. 103, p. 498).

upwards of 7000 times its weight, at 50° (one grain in about fourteen measured ounces), and 2500 times its weight at 212°. Wormley gives, as the result of many experiments, one in 8333 parts of water. But it is more or less soluble in ether, alcohol, amylic alcohol, benzole, and chloroform. It is soluble in about 1000 parts of commercial ether, 200 of absolute alcohol, 120 of amylic alcohol, 250 of benzole, and 8 of chloroform. If pure, it is not coloured by the strong mineral acids; but when it contains brucia, it is more or less reddened by nitric acid. When heated on porcelain, it melts slowly into a dark brown liquid, smokes abundantly, giving out an agreeable odour, and deposits a moderately-abundant carbon.

Tests.—*a.* The form of the crystals as above described. *b.* The intensely bitter taste. *c.* The very sparing solubility in water. *d.* The negative effect of strong sulphuric acid. Strychnine belongs to the group of alkaloids which are not changed in colour by cold sulphuric acid. Nor is any colour developed when the acid solution is warmed, and only a light yellow tint when it is heated. *e.* The chemical and galvanic colour tests. *f.* The test of sublimation.

The Colour Tests.—1. Chemical Colour Tests. *a.* Place the smallest visible crystal or granule of strychnia on a surface of white porcelain, or enamelled glass. Add a drop of pure strong sulphuric acid, and mix the acid and alkaloid thoroughly with a glass spatula. No change of colour takes place; or, if it contain brucia, a faint rose tint. Near this acid mixture place a speck of bichromate of potash, and then bring the liquid and the reagent together with the point of the spatula, having previously placed the porcelain in a favourable light. At the point of contact a deep rich blue colour makes its appearance, and on stirring the reagent into the acid solution, will extend through the whole liquid, which soon changes to purple, from purple to crimson, from crimson to a rich red brown, and then gradually fades into a bright red, which colour it retains for several hours. *b.* Proceed in the same manner with the ferridcyanide of potassium. *c.* Proceed in the same way with the permanganate of potash. *d.* Place a drop of strong sulphuric acid on the white porcelain: add a minute fragment of the peroxide of manganese (not more than will impart to the acid when mixed with it a neutral tint). Draw out a thin line of this acid liquid with the point of the spatula, and bring it in contact with a minute granule or crystal of strychnia. Similar colours will appear wherever the alkaloid is brought into contact with the mixture. *e.* Proceed in the same way with the peroxide of lead. The same colours will be developed. The description of the colours produced by these re-

agents may be simplified and more easily remembered if, intermediate shades of colour being overlooked, the succession is described as—1. The rich blue of the Orleans plum; 2. The darker purple of the mulberry; and 3. The bright clear red of the sweet orange. Of these colours, when the reaction is normal, and the colour-developing substance is at once stirred into the acid liquor, the first lasts from half a minute to forty-five seconds, the second colour, one, two, or three minutes, and the third for several hours or days. So that it is not of a mere flash of colour that we speak when describing the colour-tests, but of a successive change of colour that can be deliberately watched and readily recognised.

These tests all give highly satisfactory results, but the most delicate is the permanganate of potash.*

The colour tests are equally applicable to crystalline spots obtained by evaporating solutions of the alkaloid, or of its salts; and they react with the greatest delicacy and certainty on the sublimates presently to be described.

2. Galvanic Colour Test.—This also is applicable to a crystal or granule of strychnia, or to a deposit of the alkaloid from its solutions. Place a drop of a solution of strychnia (say one part of the alkaloid in 10,000, or even 20,000, of water) into a cup-shaped depression in a piece of platinum foil, and allow it to evaporate. When dry, moisten the spot with a drop of concentrated sulphuric acid. Connect the foil with the positive pole of a single cell of Grove's or Smee's battery, and then touch the acid with the platinum terminal of the negative pole. In an instant the violet colour will flash out, and on removing the pole from the acid the tint will remain. (Letheby.)

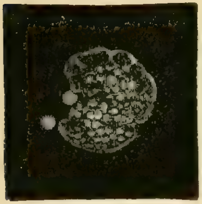
The Test of Sublimation.—This test also is one of extreme delicacy, succeeding best with such minute quantities as the $\frac{1}{100}$th down to the $\frac{1}{10000}$th of a grain. The larger quantity will yield fifteen or more successive sublimates; the smaller, at least one distinct sublimate. The coarser sublimates from the larger quantity will also yield characteristic secondary sublimates. Like the colour tests, this is applicable to the alkaloid as deposited from its solutions.

The mode of procedure is that described and figured at p. 384. A fragment of a crystal, or a speck of powder, is placed on a clean dry crucible cover, in the centre of a ring of glass. A glass disk, or microscopic slide, is dried and heated in the flame of the spirit-lamp, and placed on the ring. The flame is then

* For a careful examination of the colour-tests for strychnia, and reasons for preferring the solid to the liquid form of the soluble reagents, see a paper by the author in the 'Pharmaceutical Journal,' 1861. See, also, the same Journal, July, 1856, for an instructive paper by Mr. W. Copney.

applied to the porcelain till its temperature is considerably raised; when a mist will appear on the glass disk, and upon this, one by one, several milk-white circular spots, remaining distinct, or coalescing, are seen to form. These are often crystalline, as seen by the naked eye, and in good specimens have the appearance shown in fig. 131. Similar appearances occur (though less uniformly) in the sublimates of morphia, and they afford a strong presumption of the presence of strychnia. To such a sublimate as is here shown, and, indeed, to sublimates that are much less characteristic, the colour tests, as well as all the liquid tests which give good results with strychnia, or its solutions, may be applied with confidence. The parts of the sublimate which are least characteristic should be chosen, and to these the several reagents should be applied in succession under the microscope, the more characteristic crystalline appearances remaining intact.

Fig. 131.



When this sublimation is conducted after the manner described at p. 386, strychnia is found to remain unchanged up to a temperature of about 345°, when it will begin to yield sublimates. At 430° it melts, and continues to yield sublimates till it is exhausted, and reduced to a carbonaceous film.

When the sublimates are examined under the microscope, they are found to assume many different forms. They may consist of drops, or waving patterns, colourless, or discoloured, as if smoked; but the greater number are more or less crystalline, and may present many forms.

Crusts obtained at high temperatures, with the glass disk suitably heated, consist of characteristic isolated crystals, such as are obtained from liquid solutions (fig. 132), or they may contain such crystalline forms as are depicted at *a* and *b*, fig. 133.

Fig. 132.

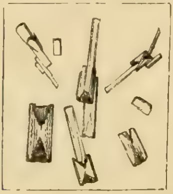
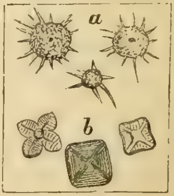


Fig. 133.



An amorphous centre, with penniform or lattice-shaped border is not uncommon, and it may be stated generally that while the sublimates of morphia (fig. 104, p. 499) are made up of curved lines, those of strychnia consist (as in fig. 134) of lines either straight or slightly curved, with parallel feathery lines at right angles.

Fig. 134.

In the coarser crusts, the dark spots, or feathered crystals, mentioned as occurring in the sublimates of morphia (p. 500), are often to be seen lying on the slide, or projecting from it. They present such forms as are shown in fig. 135.

The sublimates of strychnia, then, assume so many forms* that they are not in themselves conclusive of its presence; but it fortunately happens that there is no form that does not give with certain liquid reagents results which prove the existence of strychnia beyond the reach of doubt.

Fig. 135.

In the first place, as already stated, the colour tests act on the sublimate with extreme delicacy; so that to a small spot consisting of the $\frac{1}{10000}$ of a grain all these tests may be applied with ease and certainty, minimum drops of sulphuric acid being used, and the smallest visible speck of the colour-producing substance.

A second reaction of like delicacy is obtained by touching some portion of the sublimate which happens to present the least characteristic appearance with a minimum drop of an aqueous solution of carbazotic acid ($\frac{1}{250}$). Immediately, or in a few seconds or minutes, small round greenish brown spots show themselves, which spread and often coalesce, and become the centres of delicate arborescent crystalline groups, such as are shown in different degrees of delicacy in figs. 136, 137, and 138.

Fig. 136.

Fig. 137.

It will be observed that the elementary form in all these

* See these forms described and illustrated in a paper read by the author at a meeting of the Royal Microscopical Society, Oct. 1867, and published in its Journal.

Fig. 138.

figures is a hook or claw, or large section of a small circle. This is a rare form, and an eminently characteristic reaction; and it is one which I propose with confidence as a test for strychnia both delicate and safe, and *probably* peculiar to this alkaloid. If not peculiar, it is certain to be shared with very few other substances.

A third reaction, which is both delicate and of uniform occurrence, is that with the bichromate of potash. An aqueous solution of this substance $\frac{1}{100}$ (which, when dry, displays the delicate arborescent form depicted in fig. 99, p. 494) often instantaneously, always speedily, developes isolated yellow plates, generally square or oblong, or groups such as are shown in fig. 139.

Fig. 139.

This reaction, too, is either peculiar to strychnia, or likely to be shared with very few other substances.*

These statements, though made with caution and reserve, are nevertheless founded on experiments (in some instances often repeated) on a large number of alkaloids and analogous active principles. But it should be borne in mind that the sublimates of the alkaloids must needs resemble those of the inorganic poisons as well as crystals deposited from solutions, in being subject to great variety of form, as well as to success and failure. It should also be understood that the evidence of the presence of poisons is always cumulative, and that objections may be made to almost every reaction if taken by itself.

In the case of this test of sublimation, the evidence would be of this kind. A speck of a white powder or crystal believed to be strychnia, or a minute deposit from a solution in chloroform or benzole, or from a solution of a salt of strychnia neutralized by

* See for many minute details on this subject five successive papers in the 'Pharmaceutical Journal,' from June to October, 1867.

the vapours of ammonia, is sublimed in the manner described at p. 386. The temperature of the thermometer rises gradually beyond 200°, 212°, 240°, and 280°, at which corrosive sublimate, cantharidine, calomel, and arsenious acid, respectively sublime; and beyond the melting point of the other poisonous alkaloids, till at or about 345° it yields a sublimate or sublimates, melts at 430° and still yields sublimates till at length it is exhausted and reduced to a charcoal spot. Now all the alkaloids, and analogous active principles, liquefy and sublime, and leave a deposit of carbon; but no other among the poisonous alkaloids answers in any degree to the description now given except morphia. But this substance under experiment yields the white spotted sublimate described, and depicted in fig. 131, and in this again, corresponds with either strychnia or morphia: and, when examined by the microscope, shows the crystalline forms that belong rather to the former than to the latter. If now we submit the sublimate to the colour tests for strychnia it displays the typical succession of colours: and if the slightest doubt or misgiving remained, there would still be in reserve the remarkable, and probably quite characteristic, reactions with carbazotic acid and bichromate of potash.

2. *In Solution.*

The process for extracting strychnia from organic mixtures presents the poison not as an aqueous solution, but dissolved in ether, benzole, or chloroform. The strychnia so held in solution is allowed to deposit itself on a glass disk or slide, examined by the microscope, and then submitted to the action of the various tests. If one or more of these deposits be treated with dilute acetic acid, a soluble acetate of strychnia is formed to which the liquid tests may be applied. Assuming this procedure to be adopted, the form of the deposits from the solutions of strychnia in ether, benzole, and chloroform will first be described, and then the effect of certain chemical tests on the solution indicated.

Strychnia in ether, benzole, and chloroform.—a. In ether. This crystalline deposit usually assumes dendritic forms; but it may contain octahedra and four-sided prisms. *b. In benzole.* The solution of strychnia in benzole sometimes leaves on evaporation crystals of great brilliancy, distinctness, and permanence. The short six-sided prism is the prevailing form; but triangular and other plates of various thickness, and dodecahedra, rhomboidal and pentagonal, are occasionally met with. Generally, however, the deposit, though crystalline, does not put on the form of distinct crystals, even when the strychnia and benzole are apparently of

Fig. 140.

great purity. *c. In chloroform.* The alkaloid is deposited from this solution as rosettes, veined leaves, stellate dotted needles, circles with broken radii, and branched and reticulated forms of great delicacy and beauty. Solutions of strychnia in alcohol deposit forms similar to those yielded by the ethereal solution. (Fig. 140.)

Other Chemical Tests.—Several chemical reagents have been recommended as tests for strychnia; of which some, as the solution of iodine and iodide of potassium and tannic acid, are tests for the alkaloids as a class, others sufficiently characteristic to deserve special notice

Fig. 141.

1. The acetate of strychnia itself, to a weak solution of which the tests are supposed to be applied, crystallizes in tufts of needles (fig. 141).

2. *Carbazotic acid*, a solution of which of the strength of $\frac{1}{250}$ has been already described as a delicate and characteristic test of the strychnia-sublimate, is equally applicable to the solutions of its salts. A drop of this reagent added to a drop of the solution first occasions an abundant gelatinous deposit, which gradually gives place to curved crystals waving in the liquid, like tufts of grass, and presenting when dried the curved, and often delicately feathered forms of fig. 142.

Fig. 142.

3. A solution of *corrosive sublimate* causes an abundant white precipitate, which assumes the highly-characteristic crystalline form depicted in fig. 143.

Fig. 143.

Of other reagents it may be observed that there is no alkaloid which yields so many well-marked reactions with the many tests that have at different times been recommended.*

* Refer to papers by Dr. Letheby in 'Lancet,' June 28 and July 12, 1856, and to Wormley's 'Micro-Chemistry of Poisons.'

As the tests for strychnia are also tests for the alkaloids and analogous active principles, it may be well to state what these tests are. Those which are usually named as indicating the presence of an alkaloid by throwing down a precipitate from its solution, are—tannic acid, the iodo-iodide and iodo-hydrargyrate of potassium, and the phospho-molybdate and nitro-prusside of sodium. The sulphocyanide, chromate and bichromate, ferrocyanide and ferricyanide of potassium; the chloride of mercury (corrosive sublimate), the trichloride of gold, and the bichloride of platinum, with the sesquichloride of iron; also bromine in bromohydric acid, are largely used by those who endeavour to distinguish the alkaloids, and their analogues, the glucosides, by liquid reactions.

With solutions of the salts of strychnia these reagents, without exception, yield distinct precipitates, most of which assume, either instantaneously or speedily, crystalline forms. Sometimes the crystals show themselves as the first effect of the contact of the two liquids; but sometimes they are developed out of flocculent or gelatinous masses.

All these reactions of strychnia, as of the other alkaloids, may be studied with advantage in single drops of their solutions placed on glass slides or disks, and touched with smaller drops of the reagents:—a simple and delicate method which ought to supersede the coarser procedure of the test-tube; and which has the obvious advantage over it, of presenting every change of form and colour in a state suitable for microscopic examination.

In making use of the foregoing tests it is necessary to bear in mind that the crystalline forms described or depicted are not uniform in their occurrence; and that differences in temperature, in the strength of the solution of strychnia, and in the strength and purity of the reagents, as well as in the quantity of the reagent left unexpended, give rise to modifications in the forms of the crystals.*

The Physiological Test.—This name has been given to a test first proposed by the late Dr. Marshall Hall, who directed that frogs recently taken from the pond should be chosen; that the skin should be dried with blotting-paper; and that the liquid to be tested, being a strong solution of a salt of strychnia, should be dropped on the back. In a short time the frog thus treated became affected with tetanoid or epileptoid spasm, or convulsions. He found that this test could detect as small a quantity as the $\frac{1}{5000}$th grain of the poison; and he thought that

* It may be worthy of note, as bearing on this subject, that the depth of a drop of liquid may determine the form of the crystals deposited by it.

if inserted under the skin, or injected into the stomach, a still less quantity might be detected. The delicacy and certainty of this test have been fully confirmed by Dr. John Traill,* Dr. George Harley, Dr. Wormley, and others. Dr. Wormley† gives an account of some experiments on a small species of frog (the Rana halecina), from which it appears that when a solution of strychnia was introduced into the stomach, quantities of strychnia much less than $\frac{1}{5000}$th grain produced characteristic effects.

The experiment is best performed in a Powell's flat specimen glass. The belly of the frog being towards the flat surface; the opening is closed with a cork perforated to allow the passage of a pipette and glass rod. The skin of the frog should be dried before it is introduced into the vessel. Apply a drop or two of a solution of one of the salts of strychnia, or a solution in alcohol of the alkaloid itself, by the point of the pipette to the skin of the back. In a period of time varying from one or two minutes to a quarter of an hour or more, the characteristic tetanic convulsions will show themselves, and will recur every time the glass is shaken, or the frog touched with the glass rod. In many cases the frog utters a shriek or cry expressive of pain. When the dose is large, the symptoms show themselves almost immediately, and death takes place in a few minutes. When the dose is smaller, the symptoms come on after an interval of a quarter of an hour or half an hour, and the animal may recover. The characteristic symptom is generally ushered in by a state of evident distress, with panting respiration and protruding eye.

3. *In Organic Substances.*

The process best adapted to the detection of strychnia in the contents of the stomach, or in the animal fluids and tissues, is that originally recommended by Stas, but since modified by the substitution of hydrochloric acid for tartaric acid, and of chloroform or benzole for ether. The organic matters are first digested with about a tenth part of their bulk of hydrochloric acid over a water-bath, till they are reduced to a fluid state. This liquid is then filtered, and the substance remaining on the filter washed with distilled water so long as it has an acid reaction, the washings being added to the filtrate. The liquid is then to be somewhat concentrated by evaporation, and carbonate of soda is to be added in slight excess. The liquid is now to be strongly shaken for several minutes in a bottle or long tube with about

* 'Lancet,' July 12, 1856.
† 'Chemical News,' April 28, 1860.

half an ounce of chloroform (Messrs. Rodgers and Girdwood) or with benzole (Professor Bloxam). The chloroform having been allowed to subside, or the benzole to collect on the surface, is drawn off by a pipette, transferred to an evaporating basin, and expelled over a water-bath. If the residue left in the basin is free from colour, it may be at once tested for strychnia; but if not, it must be moistened with concentrated sulphuric acid, and exposed for some hours to the temperature of a water-bath, by which procedure all organic matter except the strychnia is destroyed. The charred mass is then treated with water, and the solution filtered to separate the carbon. Ammonia is added to excess, and the solution again shaken with about a drachm of chloroform. If, on evaporating a small portion of this chloroform solution, and acting on the residue with strong sulphuric acid, any charring takes place, the same process must be repeated. The chloroform solution ultimately obtained affords strychnia sufficiently pure for the application of the several tests. The colour tests may be applied to the deposit left on the porcelain slab after evaporation; the deposit on glass may be examined under the microscope; a solution of the deposited matter in dilute acetic acid may be examined by the several tests just described; and if the deposit is at all considerable (say the thousandth of a grain) it may be sublimed.

By this process very satisfactory results are obtained.*

Strychnia has now been detected in the contents of the alimentary canal, in the muscles and viscera, and in the blood and urine. Messrs. Rodgers and Girdwood also state that they detected it in the bones. There is no longer any room for doubt that strychnia, like arsenic, antimony, and mercury, undergoes no change in the alimentary canal, in the vessels of the body, or in the secreting organs; but that it can be detected in organic fluids and tissues by a proper method of analysis carefully and skilfully conducted.

In a medico-legal case examined by Professor Bloxam, he substituted benzole for chloroform, and obtained beautiful crystalline forms similar to those above described as characterizing the deposit from a solution of strychnia in benzole. Benzole, though a less perfect solvent than chloroform, has the twofold advantage of being lighter than water, and leaving a crystalline deposit of a more marked character.

* See the particulars of an analysis by Dr. Letheby, in a case of poisoning by strychnia, in the 'Chemical News,' September 29, 1860, and 'Br. Med. Journal,' August 4, 1860, in which a similar process was adopted.

Experiments on Animals.

The effect of strychnia on animals varies with the dose, and the state in which it is given. A large dose of a salt of strychnia given in solution may begin to act almost immediately, and kill in a minute and a half. A smaller dose may not produce any effect for several minutes, and death may not ensue for twenty minutes or half an hour; or severe symptoms may be developed, and yet the animal recover. The symptoms produced by the poison in animals are well shown in the following instance:—To a full-grown healthy rabbit, recently fed, a quarter of a grain of sulphate of strychnia dissolved in a few drops of distilled water was given. After the lapse of fifteen minutes, the animal appeared easily startled, and was tremulous, and unsteady on its legs. Soon afterwards it trembled violently, or started when touched; and slight twitchings occurred in the limbs on its attempting to move, or when a noise was made. After the lapse of eighteen minutes, when gently lifted by the ears from the table to the floor, it was seized with a violent convulsive paroxysm. The hind and fore legs were rigidly stretched out; the eyes protruded; the breathing was difficult; the pulsations of the heart could not be counted; the head and tail were drawn backwards, as if by a tightened bow-string, with occasional slight intervals of relaxation; and in this state it died, two minutes after the commencement of the convulsions, and twenty minutes after taking the poison. Immediately after death the whole body was flaccid; but it speedily stiffened, and the fore limbs altered their position, and became rigidly stretched out. In eight minutes, while the body was still warm, the muscles were rigid over the greater part of the trunk. On inspecting the body, the lungs were found collapsed, and of a bright red colour; the heart contained blood, chiefly coagulated, on both sides; the blood in all other parts of the body was liquid, and dark coloured.*

The mode and immediate cause of death in animals poisoned by strychnia are not uniform. From the experimental inquiries instituted by Dr. George Harley and Mr. Bayldon, it may be inferred that death may take place by shock, by apnœa, by syncope, or by exhaustion; and that the poison affects not the nervous centres only, but the muscular tissue of the heart, and of the voluntary muscles.

* For an account of this experiment on animals, and a collection of several cases in the human subject, with an examination of the case of Palmer, see Dr. Taylor's Essay, reprinted from the 'Guy's Hospital Reports.'

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—At an interval of from a few minutes to an hour or more after swallowing a substance which, if in solution, would have a hot and intensely bitter taste, the symptoms of poisoning set in with a feeling of suffocation and difficulty of breathing, the patient complaining of want of air. These feelings of distress are soon followed by twitchings of the muscles, and jerking movements of the head and limbs, which shortly become heightened into tetanic convulsions. The arms are flexed and tightly drawn across the chest, the legs forcibly extended and widely separated, and the feet often turned either inwards or outwards, the head bent back, and the whole body arched so as to rest on the head and heels (*opisthotonos*). The muscles of the abdomen are rigidly contracted, respiration is suspended, the pulse is very rapid, the face is livid and congested, the pupil (in the fit) is usually dilated, the eyes prominent and staring, and the features drawn into a grin (the *risus sardonicus*). The patient complains of a choking sensation, and of thirst and dryness of the throat; but the effort to drink often occasions rigid spasms of the muscles of the jaw. Sometimes there is foaming at the mouth, and the froth is occasionally tinged with blood. The violent contractions of the muscles are accompanied by pain at the pit of the stomach and cramps in the limbs, and by intense suffering and distress. After the spasms have lasted for one or two minutes there is a remission of short duration, and the patient remains exhausted, and bathed in sweat. The fits sometimes return without apparent cause, but they may be brought on by the slightest touch, or the least effort. In the intervals the patient can converse and swallow, and the jaw is not always fixed even in the fit. The mind is generally unaffected till towards the fatal termination, and may even continue clear to the last. The patient is generally quite conscious of his danger, and aware of the approach of his fits, which he announces by screams or shrieks, or by calling out that "they are coming;" and he often asks to be held, moved, or turned over. Towards the fatal termination, the fits become more frequent and severe, and the patient dies exhausted, or suffocated, in most cases within two hours of the commencement of the symptoms. If a patient survive that period there would be fair hope, but not a certainty, of recovery.

The *post-mortem appearances* in death by strychnia are not highly characteristic, nor are they uniform. As a general rule, the body would seem to be relaxed at the time of death; but it stiffens soon afterwards, and remains rigid for a long time. The

hands are usually clenched, and the feet arched, or turned inwards. In some cases the body retains the posture of the last fatal spasm. There is usually some lividity about the face, trunk, and limbs. The expression of the countenance is sometimes quite natural. The internal appearances consist in congestion of the brain and spinal cord, of the lungs and air-passages, and sometimes of the mucous membrane of the stomach. The heart is sometimes contracted, and all its cavities empty; in other cases the right side is full of blood. The blood throughout the body is black and fluid. The urinary bladder is empty.

The *treatment* consists in the prompt evacuation of the stomach by emetics or (if practicable) the stomach-pump, and then in the administration of chloroform, as liquid or by inhalation, for the relief of the pain attending the spasms. Tannic acid, and the solution of iodine in iodide of potassium, have been recommended as precipitating the poison, animal charcoal, as absorbing it, and opium, nicotine, and conia, as counter-poisons. Strong green tea, as containing tannin, may be given with advantage.

Commencement of Symptoms.—From five minutes to an hour or more. In one case, three minutes; in another two hours and a half.*

Fatal Period.—Shortest, ten minutes; longest, six hours.

Fatal Dose.—A quarter of a grain of strychnia may destroy life; but recovery may take place after doses of twenty grains or more.

From the account just given of the symptoms of poisoning by strychnia, it will be seen that they are closely allied to those of the disease known as tetanus or locked jaw. In poisoning by strychnia, as in tetanus, there are violent paroxysms of rigid convulsion, with intense suffering; and in both the mind is little if at all affected; and when it does suffer, it is apparently as the result of the exquisite tortures which the patient has undergone.

The differences between the disease, tetanus, and the effect of poisoning by strychnia are well marked. In this country, and in temperate climates, tetanus is rare, except as the consequence of a wound or severe mechanical injury. In tetanus the symptoms are at first obscure, and develope themselves gradually: in poisoning by strychnia they are strongly marked at the onset, and attain their full development in a few minutes. Tetanus begins with difficulty of swallowing, and stiffness of the jaws and neck, the trunk, legs, and arms being attacked in succession. In poisoning by strychnia, all, or nearly all, the voluntary muscles are attacked at the same time; and the muscles of the jaw are

* Wormley, 'Micro-Chemistry of Poisons,' p. 538.

not only not affected first, but sometimes wholly escape, or are violently contracted only during efforts to swallow. In tetanus, opisthotonos does not occur till after some hours or days: in poisoning by strychnia, it is among the early symptoms. In tetanus, the symptoms undergo abatement, but there is no perfect intermission: in poisoning by strychnia there are intervals of complete intermission. In tetanus the patient dies after the lapse of several hours or days, or recovers slowly after several days or weeks: in poisoning by strychnia death happens in from less than a quarter of an hour to less than three hours after the first appearance of the symptoms (death after such a period as six hours being very rare), or the patient recovers in a few hours. Tetanus brought on by direct injury to the nervous centres sometimes destroys life in a few hours.

The tetanus occasioned by strychnia is distinguished from that which occurs in the course of poisoning by other substances, irritant or narcotic, inasmuch as in the former case it constitutes the one symptom, while in the latter it occurs after other symptoms of poisoning have shown themselves; or it is mixed up with them. To this rule, however, it is possible that the salts of morphia, in certain cases, may form an exception. (See p. 507.)

The tetanic convulsions of hysteric and epileptic seizures are similarly distinguished from the tetanus of strychnia-poisoning, by forming only a part of the fit. These seizures, moreover, are not in themselves fatal. Death from hysteria is unknown, and it very rarely follows immediately or speedily on an epileptic seizure. There is a marked difference, also, in the character of the convulsive movements. Strychnia produces a rigid tremor, uniformly continuous throughout the paroxysm; whereas in epileptic, epileptiform, or hysteric convulsions, there are alternate relaxation and contraction of the muscles. In a word, the tetanic paroxysm is distinguished by uniform *rigid tremor*, the epileptic or hysteric fit by *jactitation*.

BRUCIA.

This alkaloid derives its importance from being associated with strychnia in the seed and bark of nux vomica, and in St. Ignatius' bean. It possesses the same poisonous properties as strychnia, but in a less degree of intensity, variously estimated at a sixth or a twelfth.

Properties.—Brucia is usually found in the form of a white powder; but it is readily crystallized in needles, or four-sided prisms. When thrown down by ammonia from a solution of the acetate it presents itself in long crossed needles, or in tufts, as in

Fig. 144.

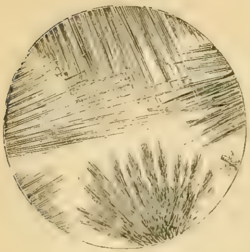


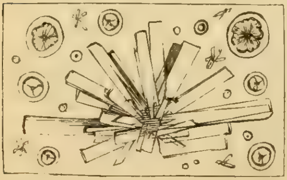
fig. 144. Both forms are obtained from the same solution by the same reagent at the same time; the needles from a drop spread over the disk, the tuft from a deep undisturbed drop.

It belongs to the group of poisons which is not changed in colour by cold sulphuric acid; and, like strychnia, it undergoes no change of colour when the acid solution is warmed. When heated, it assumes a deeper tint of yellow than strychnia. It is at once distinguished from strychnia by the intense red colour which it strikes with nitric acid. This intense colour is toned down to a faint rose tint when the brucia or the nitric acid is present in very small quantity.

Brucia, when heated on white porcelain, melts easily into a pale liquid, darkens, yields a dense vapour, and swells into a moderately abundant carbon. It gives an odour as of burnt horn. When treated in the manner described at p. 386, it melts at 240° Fahr., and sublimes at 400°. The sublimates are rarely crystalline, and are not characteristic. A solution of carbazotic acid ($\frac{1}{250}$) developes in the sublimates root-like forms. It is more soluble in water than strychnia, slightly soluble in ether, very soluble in alcohol, chloroform, and benzole. Its aqueous solution has an intensely bitter taste. With acids it forms salts.

Tests.—a. Nitric acid, as just stated, imparts to brucia and its salts a rich red colour. This red solution, if warmed and allowed to cool, is changed to purple by protochloride of tin, and bleached by an excess of the solution. *b.* Sulphuric acid, followed by bichromate of potash, developes a red or reddish-brown colour, passing to green and yellow.

Fig. 145.



In the quickness and beauty of its reactions with liquid tests brucia is second only to strychnia. Fig. 145 shows a group of crystals under a low power of the microscope from an acid solution of brucine with a solution of corrosive sublimate ($\frac{1}{100}$). Results of rare beauty are obtained with red prussiate of potash ($\frac{1}{250}$).

CHAPTER XIII.

DEPRESSANTS.

I. HEMLOCK. II. THE CALABAR BEAN. III. ACONITE. IV. TOBACCO. V. LOBELIA INFLATA.

THESE poisons occasion a loss of power disproportioned to their effect on the heart, or on the nervous centres. Hemlock and the Calabar bean may equally be taken as types of this class. In common with the poison known as curare, urari, or woorara, they are pre-eminently paralyzers of the muscles. Aconite has been classed with cardiac poisons;* and tobacco and lobelia inflata, though powerfully depressant, have not so marked an effect on the voluntary muscles.

I. CONIUM (*Conium maculatum; Hemlock; Common or spotted Hemlock*).

This plant grows in our hedgerows all over England. It belongs to the natural order Umbelliferæ, or parsley tribe, to which also belong the Æthusa cynapium, or fool's parsley, the Cicuta virosa, or water hemlock, the Œnanthe crocata, or water dropwort, and the Œnanthe phellandrium, or fine-leaved water dropwort—all poisonous plants.

The plant is readily recognised by its tall, smooth, glossy green stems, dotted with brownish-purple spots. Its root is tapering, like that of the parsnep, and its leaves have been often mistaken for those of parsley. Fig. 146 represents the conium maculatum (1) with a flower and fruit, with horizontal and vertical sections, side by side with (2) the common parsley, with its flower and fruit. The seeds are of the size and shape shown in fig. 147, and weigh about twenty to a grain. They are distinguished from other seeds of the Umbelliferæ by the presence of five prominent wavy ridges (fig. 148), and the absence of the linear receptacles for volatile oil termed *vittæ*. Every part of the plant has a strong unpleasant mousy odour, which is strongly developed

* See Dr. George Harley's paper, 'On the Influence of Physical and Chemical Agents on the Blood.' (Transactions of the Royal Society, March, 1864.)

Fig. 146.

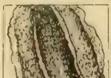
1. 2.

when the plant is rubbed with liq. potassæ. The volatile liquid alkaloid *conia*, on which its poisonous properties depend, has the same mousy odour. The leaves and fruit are in the British Pharmacopœia. The powdered leaf supplies a poultice; the fresh leaves and young branches yield the extract, and the fresh leaves the succus conii.

The recent investigations of Dr. John Harley* have shown that, with the exception of the "Succus," these preparations are either inert, or, to produce any effect, must be given in doses very many times larger than those prescribed in the British Pharmacopœia. The succus in a dose of two drachms produces the characteristic effect on the voluntary muscles. The root is described as quite inert.

Fig. 147.

Fig. 148.



The leaves are the parts of the plant usually taken as a poison; and they are reported to have produced in some instances narcotic symptoms, preceded by intoxication; in others paralysis of the muscles extending to those of respiration, and causing death by apnœa.

Symptoms.—Dryness and constriction of the throat, headache, drowsiness, dilated and fixed pupil, inability to swallow, loss of power in the extremities, passing into perfect paralysis; pulse

* See a series of papers in the 'Pharmaceutical Journal' from January to August, 1867.

small and quick, or slow and intermitting, and the respiration embarrassed. Death takes place from gradual loss of power in the respiratory muscles. Delirium, coma, and convulsions, salivation and involuntary discharge of urine and fæces, are occasional symptoms. Dr. John Harley gives a very lucid description of the symptoms produced in his own person by five drachms and a half of the *succus*. Three quarters of an hour after taking it he first found that he had lost the power of quick adjustment in the muscles of the eye. In another quarter of an hour this symptom had much increased, and a general muscular lethargy, with heavy eyelid, and dilated pupil supervened. In another quarter of an hour there was squeamishness and faintness, and he was cold, pale, and tottering. The nausea passed off, but the muscular weakness increased. The mind was quite intact, and the pulse, after the first excitement, was sixty-eight, and regular. There was "a direct diminution of power in all the voluntary muscles, almost amounting to paralysis," and "the greatest exertion was at one time required to elevate the eyelids." In $3\frac{3}{4}$ hours all the symptoms of poisoning had passed off. Similar symptoms occurred in two young women who took three and four drachms respectively of the succus.

Post-mortem Appearances.—Those of apnœa, with redness of the mucous membrane of the stomach, and congestion of the vessels of the brain.

Treatment.—After emptying the stomach by emetics, a full dose of castor oil to remove the poison from the bowels; followed by the treatment proper to apnœa, including the free use of diffusible stimulants.

Commencement of Symptoms.—From a few minutes to a quarter of an hour or more.

Fatal Period.—From one hour to four hours.

Fatal Dose.—The smallest dose is not ascertained; but from experiments on animals it appears that a single drop of the alkaloid will kill a cat in three minutes, and five drops a dog in one minute.

CONIA (*Conein, conicin, conicina*).—This alkaloid destroys life in the same way—by producing apnœa. It does not seem to paralyse the heart; but affects the whole system of voluntary muscles, in common with the muscles of respiration. In some experiments on animals *conia* has been found to give rise to tetanic spasms. The pupils were stated to be *dilated* and insensible.

In one of Wormley's experiments, a single drop was placed on the tongue of a large healthy cat. In a few seconds the animal stood still, and showed an unsteady gait when disturbed. In two

minutes and a half it fell on its side, voided urine, had strong convulsions and universal tremor, and died in three minutes.

Properties.—When pure, it is an oily, volatile, colourless liquid; but turns yellow and darkens by keeping. It has a pungent odour, as of stale tobacco; gives a greasy pink stain to filtering paper; is very soluble in alcohol, ether, and chloroform; but insoluble in water. With acids it forms salts. It fumes with the vapours of nitric, hydrochloric, and acetic acids. Like the fixed alkaloids, it deposits carbon when heated, and yields precipitates with the iodo-iodide of potassium and tannic acid.

Tests.—*a.* Sulphuric acid produces no immediate change, but after many hours the green oxide of chromium is formed. *b.* Nitric acid deepens its colour, and gives out with it dense white fumes. *c.* Strong hydrochloric acid imparts a pale red tint, which deepens, and leaves groups of needles. *d.* Its vapour, acting on a drop of a solution of carbazotic acid ($\frac{1}{250}$), developes the crystalline forms, fig. 149, contrasted with the delicate forms arising from a similar reaction with nicotine (fig. 150). *e.* Oxalic acid forms with it a crystalline oxalate of conia.

Fig. 149.

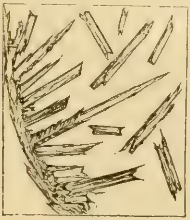


Fig. 150.

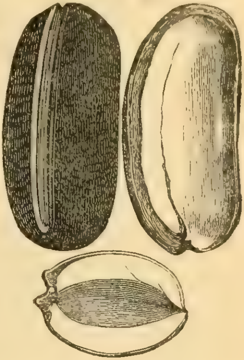
II. PHYSOSTIGMA VENENOSUM (*the Ordeal Bean of Calabar*).

The seed or bean of the leguminous plant Physostigma venenosum is now imported from Western Africa, and is admitted into the British Pharmacopœia, to which it supplies the extractum physostigmatis. Its chief use is in ophthalmic surgery, as an efficient means of contracting the pupil. We have become acquainted with its action as a poison through the researches of Christison, George Harley, Nunneley, and Fraser. Christison wrote on the subject as early as 1855, and Dr. Fraser has published an exhaustive essay upon it so lately as 1867.*

* 'On the Physiological Action of the Calabar Bean.' By Thomas R. Fraser, M.D. ('Trans. Roy. Soc. Edinb.' vol. xxiv.)

The bean is about the size of a pigeon's egg, and has the shape of a kidney. It has a hard, shining shell of a deep chocolate colour, and contains two white cotyledons, hollowed and marked as in the annexed illustration (fig. 151), which shows the bean of its natural size and with a vertical and transverse section. The white substance of the bean is free from bitterness, acrimony, or aroma. The absence of any property likely to attract attention or prove repulsive is sufficiently shown by the fact that, in the summer of 1864, fifty children ate the beans at Liverpool, of whom one died. The white cotyledon assumes an orange tint when touched with nitric acid, and a yellowish brown when treated with permuriate of iron. The bean owes its activity to an alkaloidal principle to which the name of *physostigmine* has been given, but of which the chemical properties have yet to be examined. Its effect in contracting the pupil is eminently characteristic.

Fig. 151.



Experiments on Animals.—Dr. Fraser describes the effect of a small and of a large dose in terms of which this is an abbreviation. *A small fatal dose*, given to one of the lower animals, first occasions a slight tremor, extending from the hind-quarters to the fore-limbs and head, and then paralysis and muscular flaccidity setting in in the same order. The rectum and bladder are then emptied. The pupils generally *contract*, the breathing becomes slow, irregular, and stertorous, and frothy mucus escapes from the mouth. Muscular twitchings occur, and often continue after respiration has ceased. Reflex action cannot be produced, the parts about the eye are insensible, and on lifting the animal by the ears the limbs hang inert, and a few gasping respirations usher in death. Immediately after death the pupils dilate. Consciousness is evidently preserved. On opening the body, the muscles are found to contract when cut, the heart acts regularly, and the intestines retain their vermicular action. The lungs are excessively engorged. *A large fatal dose* almost immediately paralyses the hind legs; the animal falls, lies flaccid, and shows muscular power only by a few twitches. The pupils contract, and the secretions of the eyes and mouth are increased.

Reflex action cannot be produced, and, after a few gasps, respiration ceases. The pupils dilate after death. On opening the body, muscular twitchings occur, the heart is found distended, and retains its irritability for about ten minutes. The vermicular action of the intestines is scarcely perceptible.

The poison has proved fatal to every living creature on which it has been tried, except the Esĕrĕ moth; it is a poison of the class to which belong conia and curare.

The effects of doses short of poisonous are well shown in the result of experiments made by Christison on his own person. Twelve grains of the seed, chewed and swallowed, acted in twenty minutes, causing giddiness and torpor. After emptying the stomach by an emetic, the giddiness and weakness continued such as to oblige him to lie down. He was found pale and prostrate, with a weak and very irregular pulse, but the mental faculties intact. Two hours after taking the poison, he felt drowsy, and for other two hours fell into a sort of conscious sleep. The symptoms then gradually went off, and next day he was quite well.* In the children who ate the beans at Liverpool, symptoms of internal irritation were present, with contracted pupil, pale face, and staggering gait.

The poison causes contraction of the pupil, whether taken internally or applied externally. In the case of local application of the extract, the effect shows itself in about ten minutes, and lasts for several hours. This contraction of the pupil is, at present, our only test of the presence of this poison.

The treatment of poisoning by the Calabar bean would consist in the prompt use of emetics, followed by the measures suited to the state of apnœa.

III. ACONITE (*Aconitum Napellus, Monkshood, Wolfsbane, Blue-rocket*).

With the exception of the Aconitum ferox, which grows on the Himalayan mountains in India, the Aconitum napellus is the most active poisonous plant of the many that go by the name of *aconite*. Some of them have no poisonous property whatever. But not only is the Aconitum napellus, with this single exception, the most active poisonous plant bearing the name of aconite; it is also, when compared with other poisonous plants, a very fatal one; and there is reason to believe that *aconitina*, the active principle of the plant, is the most deadly poison in existence.

* 'Pharmaceutical Journal,' 1855, p. 474.

Monkshood belongs to the Linnæan class and order *Polyandria trigynia*, and the natural order *Ranunculaceæ*, or *crowfoots*. It is a beautiful plant, from two to six feet in height, with dark-green leaves, of very characteristic form, and a terminal spike of rich blue flowers. It grows on hilly ground in many parts of Europe, is supposed to be indigenous, and is often cultivated as a garden flower. Fig. 152 shows a cutting of the plant.

Fig. 152.

All parts of the plant are poisonous, but the root is the most active. Both *root* and *leaves* have been several times taken as poisons; and the *extract* and *tincture* have also proved fatal.

The leaves and root are in the British Pharmacopœia. The fresh leaves and flowering tops yield an *extract* of which the dose is from 1 to 2 grains; and the dried root a *tincture* ($2\frac{1}{2}$ ounces to a pint—dose, 5 to 15 minims) and a liniment (1 ounce to a fluid ounce).

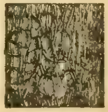
The leaves, seeds, and root are easily identified.

The *leaves* are completely divided to the base into five wedge-shaped lobes, which are again divided into three, the segments being linear. They are not liable to be mistaken for the leaves of any other plant.

The *seeds* are numerous, three-sided, irregularly twisted, and wrinkled, of a black or dark-brown colour, a sixth of an inch long, weighing 25 to the grain. Fig. 153 shows their size and shape, and fig. 154 the markings on their surface, as seen under the microscope. A single seed contains enough of the active principle of the plant to produce numbness and tingling of the lips, tongue, and throat.

Fig. 153.

Fig. 154.



The *root* has more than once been scraped and eaten instead of the horse-radish. This accident occurred in 1836 to a Mr. and Mrs. Prescott and their child, whose cases are minutely described by Pereira; in 1842 to a lady residing at Lambeth (Taylor); in the winter of 1853 to two brothers, of whom one died and the other recovered. Still more recently, in the winter of 1856, the poison killed two priests at Dingwall, and a third person out of five who were affected at a dinner there. In the next year, 1857, a case occurred in London. The recorded cases are now very numerous. The root has also been given intentionally in one instance at least.

It is not easy to understand how the root of monkshood should have been mistaken for that of the horse-radish, even though the respective plants were not attached to the roots to render the mistake impossible; for though the section of both roots is white when fresh, the scrapings of monkshood are friable and succulent, those of the horse-radish tough and stringy, and the first soon acquire a pink colour while the second remain white. The two roots differ in shape, colour, and taste. The root of monkshood is conical, and throws off a large number of curling fibres, and it is not unusual to find one or more pear-shaped tubers, attached by narrow necks to the upper part of the root-stock, as in the specimens shown in fig. 155, which, with the single root in fig. 156, were selected out of a large number of freshly-dug roots of Aconitum napellus, as presenting the most characteristic varieties of form. The figures are of the size of the roots themselves; but it must be understood that the single root may attain two or three times the size depicted in fig. 156. On the other hand, the root, or, as it is commonly called, the stick of the horse-radish (fig. 157), is cylindrical in all its larger branches, and throws off straight rootlets. The colour of the monkshood-root is a dark nut-brown externally, that of the horse-radish is buff-coloured. The root of the monkshood when chewed soon causes a peculiar tingling and numbing sensation in the lips, with a feeling of enlargement, and a similar sensation in the throat, when swallowed; and this sensation in the lips and throat continues for several hours: the taste of the horse-radish is pungent and sweet; causing profuse lachrymation, but not being very persistent.

This peculiar numbness and tingling of the lips is produced by the leaves and seeds, and, indeed, by every part of the plant.

Experiments on Animals.—These have been made with monkshood, and its active principle aconitina, by Brodie, Orfila, Christison, and Pereira, and more recently by Drs. Fleming and Headland.

Fig. 155.

Fig. 156.

Fig. 157.

According to Dr. Fleming, aconite, when introduced into the system of one of the lower animals, causes, successively, weakness of the limbs and staggering; accelerated, or slow and labouring respiration; paralysis; diminution, or total loss, of sensibility of the surface; dimness of vision, or actual blindness; increasing difficulty of breathing; and, after a few spasmodic twitches, death by *asphyxia.* On examining the body immediately after death, the heart is found beating with considerable strength, which it continues to do for some time; the peristaltic action of the intestines also continues; the irritability of the voluntary muscles is impaired but not extinguished; there is general venous congestion, with distension of the right side of the heart and large veins, and venous blood is usually found in the left cavities of the heart, and in the aorta. The venous system of the brain is often gorged with blood. Dr. Fleming adds that in some of his experiments there were decided convulsive movements, and, in two instances, distinct opisthotonos; that in general the pupil was more or less *contracted;** that the pulse became weaker and less frequent; and that the poison did not appear to give rise to any local irritation. From other experiments of Dr. Fleming's it would appear that aconite proves poisonous to vegetables.

It would seem that aconite occasions muscular debility or actual paralysis, extending from the muscles of the extremities to those of the chest; that it acts as a sedative to the heart; that it impairs or destroys common sensibility; and that it proves fatal by inducing *asphyxia.* Asphyxia, however, is not the only mode of death in poisoning by monkshood; for Dr. Fleming distinctly recognises three possible modes:—1. A *powerfully sedative impression on the nervous system*, death taking place in a *few seconds;* 2. *Suspension of the respiratory function;* and 3. *Syncope. Shock*, *asphyxia*, and *syncope*, then, are the three modes of death in animals poisoned by aconite. In the human subject, according to Dr. Fleming, syncope is the common cause of death.

The *symptoms* of poisoning by monkshood in the human subject are:—numbness, tingling, and burning heat in the mouth, throat, and stomach, followed by nausea and vomiting, with pain and tenderness of the epigastrium. The numbness and tingling speedily become general, with diminished sensibility of the surface, vertigo, dimness of vision, or complete blindness, tinnitus aurium, and occasionally deafness; frothing at the mouth; sense of constriction in the throat, with sensations of weight and en-

* This statement is opposed to Dr. Headland's experience. He found that it caused in animals dilatation of the pupil, but in a less degree than belladonna. ('Lancet,' March 29, 1856.)

largement of various parts of the body, but especially of the face and ears; great muscular feebleness, with general trembling; more or less difficulty of breathing, and speechlessness; a distressing sense of sinking at the pit of the stomach, and dread of approaching death. The pulse becomes small, feeble, irregular, and finally imperceptible both at wrist and heart; the extremities, and afterwards the whole body, become cold, and a clammy sweat bedews the surface; finally, the countenance grows blanched, the lips bloodless, and with a few hurried gasps, the individual expires. The mental faculties usually remain perfect till the last, but there may be slight delirium. There is no tendency to sleep. Death is often sudden.

Post-mortem Appearances.—General venous congestion, and, in some cases, engorgement of the brain and its membranes, with considerable sub-arachnoid effusion; also occasionally signs of gastro-intestinal irritation.

Commencement of Symptoms.—In a few minutes, or not for one or two hours.

Fatal Period.—Shortest, an hour and a quarter; longest, twenty hours; average, less than four hours. The majority of deaths occur within three hours.

Fatal Dose.—Of the root, it is believed that less than a drachm has proved fatal; of the alcoholic extract, four grains; of the tincture, a drachm. But very severe symptoms have been produced by much smaller quantities.

Treatment.—There is no antidote to this poison, unless animal charcoal, recommended by Dr. Headland, is to be considered in that light. The treatment will therefore consist in the prompt administration of an emetic, followed, after an interval of time, by a full dose of castor oil. Stimulants, such as hot brandy and water and ammonia, must then be freely administered, and strong coffee may be given with advantage. Dr. Fleming also recommends friction of the spine and limbs with warm cloths and spirituous liniments, and sinapisms, or bottles of hot water, to the præcordia and extremities; and that convulsions, if they come on, should be treated by opening the jugular vein; and great dyspnœa, and extreme feebleness of the heart's action, by artificial respiration, and slight galvanic shocks passed through the heart.

Diagnosis.—In some instances we are able to identify portions of the plant itself in the contents of the alimentary canal. An alcoholic extract of the contents of the stomach, applied to the lips, produces the peculiar numbness and tingling already described, and if given to some of the smaller animals would be identified by its fatal effects.

Aconitine.—This alkaloid is so active a poison that, according to Headland's experiments, $\frac{1}{300}$ of a grain will kill a mouse; $\frac{1}{100}$, a small bird in a few minutes, and $\frac{1}{50}$ almost instantaneously; $\frac{1}{20}$ of a grain a cat, and $\frac{1}{10}$ of a grain the same animal in twenty minutes or half an hour. Dr. Headland is of opinion that $\frac{1}{10}$ of a grain would kill an adult man, and Dr. Herapath performed an analysis in a case at Bristol, from which he inferred that $\frac{1}{20}$ of a grain had proved fatal. $\frac{1}{1000}$ of a grain causes tingling and numbness of the tip of the tongue, and $\frac{1}{100}$ of a grain dissolved in spirit, and rubbed into the skin, causes loss of feeling, lasting for some time. Aconitina may be separated from organic liquids by the method of Stas, or by a similar method suggested by Dr. Headland. In the fresh root, the alkaloid is contained in the proportion of a quarter to three quarters of a grain in the ounce, and in the dried root, of twelve to thirty-six grains to the pound.

Properties.—Aconitine is generally sold as a white amorphous powder; but it may be obtained in small crystalline masses, or even in well-formed colourless crystals. It belongs to the group of alkaloids which are not changed in colour by cold sulphuric acid; but it is characterized by assuming a deep brown tint when *warmed.* Nitric acid dissolves it without change of colour.

When heated on porcelain, it readily melts into a yellow liquid, gives off a light vapour, and spreads into an abundant carbonaceous layer. When heated in the manner described at p. 386, it melts at the characteristically low temperature of 140° Fahr., and at 400° yields sublimates which are not crystalline.

The alkaloid is moderately soluble in water, and has a strong alkaline reaction. It is soluble in alcohol, ether, and benzole; and very soluble in chloroform. It is also soluble in acids, but its salts are not crystalline. It has the taste, and produces the peculiar impression on the lips, tongue, and palate described above.

Tests.—*a.* The peculiar effect on the lips, tongue, and palate. *b.* The reaction with sulphuric acid. *c.* The absence of change with nitric acid. *d.* The low temperature at which it melts, and the high temperature at which it sublimes, with the unpronounced character of the sublimate. *e.* The absence of precipitate with iodide of potassium and bichloride of platinum.

IV. TOBACCO (*Nicotiana tabacum*).

The Nicotiana tabacum, or Virginian tobacco, is a plant which belongs, as do so many of our chief poisons—hyoscyamus, belladonna, and stramonium,—to the artificial class and order *Pentandria monogynia,* and natural order *Solaneæ* (fig. 158).

Tobacco contains, as the source of its activity, a liquid volatile

alkaloid, and a concrete volatile oil, known as tobacco-camphor. These active ingredients are obtainable from all parts of the plant, and are contained in the infusion and decoction, and in the smoke, blended with carbonate and acetate of ammonia, and several gases. The dried leaves have a place in the British Pharmacopœia, and supply the enema tabaci—twenty grains to eight ounces.

Fig. 158.

Experiments on Animals.—The effects produced by tobacco on carnivorous animals (for the herbivora are less affected, and differently) are: nausea, vomiting, sometimes purging, universal tremors, staggering, convulsions, and stupor. In the experiments of Orfila, ℥vss of rappee introduced into a dog's stomach, the gullet being tied, killed the animal in nine hours; and ℥ij applied to a wound killed another animal in an hour.

Infusion of tobacco, as appears from the experiments of Sir Benjamin Brodie, paralyses the heart, acting, as other experiments prove, through the nervous system; but the empyreumatic oil of tobacco acts differently, for a single drop placed on the tongue of a cat caused convulsions and death in two minutes, and on opening the body, the heart was found beating with regularity and force.

Symptoms.—Tobacco produces like effects on the human subject. The first symptoms are a quickening and strengthening of the pulse, with very transient excitement, followed by sudden giddiness, fainting, and great sickness, accompanied with a weak, quivering pulse. These effects are generally transient, but sometimes they are more serious. Marshall Hall relates the case of a young man who smoked two pipes for his first debauch, and was seized, in consequence, with nausea, vomiting, and syncope, then with stupor and stertorous breathing, general spasms, and insensible pupil. Next day the tendency to faint continued, and in the evening

the stupor, stertor, and spasms returned, but from that time he recovered steadily. Other authors have reported cases of death from excessive smoking. Fatal results also sometimes follow the introduction of the infusion or smoke into the bowels; and severe effects have also followed the abuse of snuff, external application of tobacco, and sleeping surrounded by bales of the weed.

Commencement of Symptoms.—After a few minutes.

Fatal Period.—Shortest, eighteen minutes.

Fatal Dose.—Half a drachm (Copland).

Post-mortem Appearances.—Not very characteristic. Turgescence of the vessels of the brain, and inflammation of the stomach have been found.

Treatment.—If taken in substance, and not discharged by spontaneous vomiting, emetics must be first administered. The after-treatment must consist in the free use of stimulants.

NICOTINE (*Nicotia*).—This alkaloid has acted fatally as a poison in two instances: one in Belgium in 1851, when it was administered by Count Bocarmé to his brother-in-law, the other in London in 1858, the act being suicidal. The alkaloid acts with the rapidity, and somewhat after the manner, of prussic acid. Dr. Taylor found that a single drop killed a rabbit in three minutes and a half, with tetanic convulsions. The victim of Count Bocarmé does not seem to have survived five minutes; and in the suicidal case death was quite as rapid. The patient was observed to stare wildly, and to die without convulsions, while heaving a deep sigh.

The *post-mortem appearances* in this case were general relaxation of the muscular system, staring eyes, bloated and livid features, the vessels of the scalp and membranes of the brain, and those of the lungs, gorged with black blood, and the cavities of the heart, with the exception of the left auricle, empty. There was intense congestion of the mucous membrane of the stomach, and of the liver. The blood was black and liquid, and, in some parts, had the consistence of treacle. Nicotine was detected in the stomach, liver, and lungs, by a process similar to that of Stas.*

Properties.—Nicotine resembles conia in being a liquid and volatile alkaloid. When quite pure, it is a colourless oily liquid, but assumes an amber hue on exposure to the air, and deepens in tint by keeping. A drop placed on a white surface of enamelled glass has a green colour, while conia is pink; and if the liquids are dropped on filtering paper, they produce greasy stains

* See Taylor, 'On Poisons,' p. 750.

of the same colours. Nicotine has an acrid taste, but a pleasant ethereal odour;* while conia has a disagreeable odour, which might be mistaken for that of stale tobacco. Nicotine is soluble in water and in alcohol, ether and chloroform—its best solvent. The three mineral acids do not change the colour of the alkaloid. With the vapours of the two volatile acids, it yields white fumes less dense than those with conia. The aqueous solution has a decided alkaline reaction. With acids, the alkaloid forms fixed salts, and with several reagents characteristic crystallizable compounds.

Tests.—a. Nicotine resembles conia and the fixed alkaloids in the effect of heat, and in the precipitates which it yields with the solution of iodine in iodide of potassium, and with tannic acid. *b.* Sulphuric acid combines with it without change of colour. *c.* Nitric acid also does not change the colour of the alkaloid. *d.* Corrosive sublimate throws down a white deposit, which is found to consist of well-defined groups of transparent plates, arranged as flowers, winged insects, and rosettes. *e.* Bichloride of platinum yields a well-marked precipitate. *f.* Carbazotic acid also yields a distinct crystalline precipitate. *g.* Oxalic acid gives with the alkaloid, crystals of oxalate of nicotine.

In some of these reactions nicotine resembles ammonia. It is sufficiently distinguished from it by the fact, that ammonia reddens tannic acid, and gives with the solution of iodine in iodide of potassium a dark-green precipitate.

V. LOBELIA (*Lobelia inflata, Indian Tobacco, Bladder-podded Lobelia*).

Lobelia inflata belongs to the artificial class and order *Pentandria monogynia,* and natural order *Lobeliaceæ.* It is a native of North America, and has long been used by the aborigines: it at length became a quack medicine among the American irregular practitioners, was the subject of favourable notice by a clergyman (Dr. Cutler), and of a work by an English physician, Dr. Reece, in the year 1829, in which work it was highly commended as an *anti-asthmatic.*

The herb is usually imported into England by the Shaking Quakers of New Lebanon, North America, compressed into oblong cakes weighing half a pound or a pound each, wrapped in blue paper. The seeds, and a powder of the seeds, are sold by all the herbalists. Both have proved fatal several times in America and in England.

* This odour has been retained by two specimens now for many years in my possession.

The dried herb is of a pale green colour; it has a nauseous odour, and acrid burning taste, closely resembling that of tobacco. The taste and odour are believed to be due to a volatile oil, to a resinous alkaloid (lobelin), and to a peculiar acid.

The dried herb has a place in the British Pharmacopœia, and yields two tinctures—the tinctura lobeliæ, and tinctura lobeliæ æthereæ ($2\frac{1}{2}$ ounces to the pint, and dose ten to thirty minims).

The seeds are brown grains of the small size shown in fig. 159, and weigh 3176 to a grain. They have the shape and microscopic characters depicted in fig. 159.

Fig. 159.

Lobelia is an active medicine, and a potent poison. In ten-grain or scruple doses of the powdered leaves or seeds it is a strong nauseating *emetic;* and has, indeed, been termed the *emetic weed.* A teaspoonful, or a drachm, is a fatal dose.

The symptoms caused by lobelia are speedy vomiting followed by distressing nausea, with headache, giddiness, and tremors, copious sweats, and extreme depression. Diarrhœa and dysuria are sometimes present. Sometimes the pulse intermits, as a consequence of its depressant effect on the circulation. The fatal event is ushered in by convulsions. Employed as an enema it acts as tobacco does, causing the same sickness and tendency to faint.

Fatal Dose.—A case of poisoning by a drachm of the powdered leaves occurred in England in 1847.

Fatal Period.—In this case death happened in about thirty-six hours.

Post-mortem Appearances.—The mucous membrane of the stomach intensely inflamed, and the vessels of the brain strongly congested.

The *treatment* of poisoning by lobelia consists in promoting vomiting by draughts of warm water, and tickling the throat; following this up by the free use of stimulants to counteract the depressing effect of the poison.

CHAPTER XIV.

ASTHENICS.

I. HYDROCYANIC ACID. II. OXALIC ACID. III. DIGITALIS.

THE three poisons at the head of this chapter are grouped together under a heading which is intended to imply that they occasion death by *asthenia*, or shock. The first two destroy life very quickly in this way, the third (digitalis) by a slower action on the heart. In everything but in this production of sudden death, the first two poisons are strongly contrasted; and in nothing more than in the absence of corrosive action in the one and its presence in the other. The three may be brought together under the designation of *cardiac poisons*, to which class also belong the Antiaris toxicaria, antiar, or upas; the Tanghinia venenifera; and more than one of the arrow poisons.

I. HYDROCYANIC ACID.

Hydrocyanic, or prussic acid, essential oil of bitter almonds, of which it is the active principle, and cyanide of potassium, one of its salts, form a group of poisons ranking next in order to opium and its preparations.

In the two years 1837–8, twenty-seven cases of poisoning by prussic acid were brought under the notice of the coroner's court, of which eight (all cases of suicide) occurred in medical men and druggists. Four cases of poisoning by essential oil of almonds also occurred in those years, and one of poisoning by prussic acid and arsenic. Prussic acid, with its preparations and compounds, caused, on the average of those years, sixteen deaths. But on the average of the five years 1852–56, they were credited with 34 out of the 268 deaths from ascertained poisons. The use of this poison is, therefore, on the increase.

In the five years, 93 deaths were attributed to prussic acid, of which 83 in males and 10 in females; 75 to essential oil of almonds, of which 45 in males and 30 in females; and 2 to

cyanide of potassium, of which one in a male the other in a female. There was one murder only, and that by the essential oil of almonds. The remainder of the deaths were suicidal or accidental; and 75 by prussic acid, 51 by essential oil of almonds, and 1 by cyanide of potassium were ascertained suicidal acts.

This poison is remarkable for its quick and fatal effect, and this, coupled with the frequent use of the essential oil of almonds in cookery, and of the cyanide of potassium in the arts, renders it a favourite instrument of suicide. For medicinal purposes, the acid is formed by a complex chemical process, or by the decomposition of salts which contain it; but it also exists in the leaves, flowers, and fruit-kernels of many plants belonging to the natural order Rosaceæ. The bitter almond, cherry-laurel, peach, cluster cherry, and mountain ash; the kernels of peaches, plums, and cherries, and the pips of apples contain it. The prussic acid obtained from these sources is mixed with an essential oil, and distils with it. The cherry-laurel water was given as a poison in the well-known case of Sir Theodosius Boughton; and a bitter almond water improperly kept in the shops of very variable strength, and incautiously prescribed, has also proved fatal.

The acid is met with as the pure anhydrous acid, and diluted with water. The first is without colour, has an acrid pungent taste, and a peculiar odour; boils at 80°, freezes at 5°, and at common temperatures freezes by its own evaporation. It is highly inflammable. By exposure to light, it soon decomposes and turns brown. The pure acid has no medico-legal interest: it is the dilute acid of the shops that is commonly used as a poison.

Dilute Hydrocyanic Acid.

Properties.—The dilute has the same appearance, odour, and taste as the strong acid, but if kept from the light is not so apt to decompose. It is volatile, and becomes less active by exposure. But the acid obtained by decomposing a solution of ferrocyanide of potassium with sulphuric acid is much more stable, and has been kept for years, exposed to diffused light, without undergoing decomposition. The medicinal strength of the acid differs with the mode of preparation, and the time it has been kept. It has been found to vary from 1·3 to 6·5 per cent. (Taylor).

The acid of the British Pharmacopœia should contain about 2 per cent., that of Vauquelin, 3·3, and that of Scheele about 5 per cent. The strength, as used in different countries, varies greatly.

Among the properties of prussic acid just described, there is

one so characteristic and so delicate as to be justly regarded in the light of a test, namely—

The odour.—This is peculiar, and perceptible even in weak specimens; and it has the advantage of not demanding chemical knowledge or skill in the observer, and when perceived by more than one person at the same time, it is conclusive of the presence of the acid. It has, indeed, been alleged that the odour is not decisive; because nitro-benzine, a product of coal-tar, and some other artificial products used as scents or flavours, and also the brain itself, have a like odour. Of nitro-benzine it will suffice to observe that it is itself an active poison (see p. 533); of the objection founded on the faint similar odour of the brain, that it has a very limited application in post-mortem inspections, and of both that they are very unlikely ever to constitute real objections.

The odour of the acid, considered as a highly characteristic property and test, finds its application both during life and after death—during life, by the odour diffused through the air, or perceptible in the breath; after death, at the mouth, in the contents of the stomach, and in the tissues.

In patients under treatment, the odour of the acid may be disguised, as in the case that fell under my observation, in which assafœtida was used in an injection.

The odour, as perceived in the dead body, though generally recognisable soon after death, may disappear in less than twenty-four hours. In the case of Sarah Hart, the victim of Tawell, it was perceived by two only out of five witnesses, eighteen hours after death; in a case reported by Mr. Newham, of Bury St. Edmunds, after eleven hours in the stomach, heart, and brain; and in an interesting case of double suicide (that of C. W. Duckett and Elizabeth Williams, reported by Dr. Letheby), about the mouth twelve hours, and according to Mr. G. Davies, seventeen or eighteen hours, after death.

The odour of prussic acid is therefore a highly characteristic property, and valuable test of the presence of the poison.

Tests.—There are four recognised tests for prussic acid, which may be briefly designated as the copper, silver, iron, and sulphur tests. These tests are equally applicable to the acid in solution and in vapour.

1. *Copper Test.*—The liquid is first rendered slightly alkaline by liquor potassæ; and on adding a solution of sulphate of copper, a greenish-white precipitate is thrown down, which, on adding a little hydrochloric acid to redissolve the blue oxide, becomes nearly white.

2. *Silver Test.*—A solution of nitrate of silver gives with liquids containing hydrocyanic acid a white clotted precipitate, distinguished by its insolubility in nitric acid at common temperatures, and its solubility at a boiling heat. If the precipitated cyanide of silver, washed and dried, is introduced into a small tube closed at one end, and drawn out at the other into a fine point, and the precipitate is heated by the flame of a spirit-lamp, cyanogen gas is driven off, which, on being lighted, burns with a highly characteristic crimson flame, surrounded by a blue halo.

3. *Iron Test.*—Add to the suspected liquid a little liquor potassæ, then a few drops of the mixed protosulphate and persulphate of iron in solution. A brownish-green precipitate is thrown down, which, on the addition of a little dilute hydrochloric acid, becomes Prussian blue.

4. *Sulphur Test.* (Liebig's Test.)—To the liquid containing the acid add a few drops of sulphide of ammonium; heat the liquid gently till it becomes pure white or colourless; then evaporate slowly. A white amorphous sulphocyanide of ammonium remains, which assumes an intense cherry-red colour when touched with a solution of perchloride of iron : a colour not discharged by corrosive sublimate.

When these tests are applied to detect the acid by its *vapour*, the following method of procedure is to be observed :—

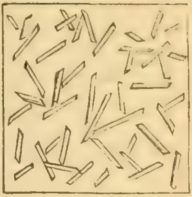
Place the fluid or substance yielding the vapour in a watch-glass; moisten a large flat disk of glass with the test; invert it over the watch-glass, with the moistened surface downwards, and allow it to remain till a distinct reaction is perceptible through the disk. Or, place the liquid or substance in a small wine-glass with a conical stem, moisten with the test two flat glass disks—a smaller and larger one—and place them in the glass, so that the vapour that passes the first may act on the second.

In the case of the *copper test* use a weak solution of sulphate of copper (1 gr. to the ounce). Moisten the glass disk with a drop of this solution rendered slightly alkaline by liquor potassæ; and after exposure add a drop of dilute hydrochloric acid. Compare the dried stain with that from a drop of the test-solution.

In the case of the *silver test*, moisten the glass disk with a weak freshly made solution of nitrate of silver (gr. 1 to f℥j). The colourless solution soon becomes opalescent, and when dry, leaves a white stain, which examine by the microscope. It will be found to consist of distinct prisms, or long plates, more or less thickly interlaced (fig. 160). Compare the stain with that left by a drop

of the test solution. It is faintly white, and shows under the microscope no distinct crystalline form.

Fig. 160.



In the case of the *iron test*, moisten the glass disk with a drop of liquor potassæ, and after due exposure, add a drop of the fresh solution of the mixed sulphates of iron. Develope the Prussian blue by a drop of dilute hydrochloric acid. Compare with the Prussian blue the brown oxide of iron thrown down by adding liquor potassæ to the test liquid.

In the case of the *sulphur test*, moisten the glass disk with sulphide of ammonium, allow the white stain of cyanide of ammonium to dry, and test with a drop of perchloride of iron solution. Compare the cherry-red of the sulphocyanide with the yellow of the dry spot of perchloride of iron. To increase the contrast use a solution of the perchloride diluted with distilled water so as to be nearly colourless. As the liquid in the watch-glass will have absorbed some of the vapour of the sulphide of ammonium, and turned white, it should be evaporated to dryness, and tested with the perchloride of iron. As two vapours are in presence of each other, this test may always be applied both to the stain and to the liquid under examination.

Of these four tests of prussic acid in vapour, I have found the silver test the most satisfactory. A single apple-pip bruised and moistened with distilled water, and placed in a watch-glass, yielded as many as twenty-two distinct reactions. The solution of nitrate of silver was rendered opalescent in every instance, and the dried stain was found to contain microscopic crystals of the cyanide. The results obtained with the other tests in experiments made under exactly similar circumstances, were less satisfactory. Three apple-pips were bruised, moistened, and placed in three watch-glasses; and the three tests were used in the manner already described for ten successive exposures of five minutes each. The nitrate of silver acted characteristically in the ten experiments; the Prussian blue test succeeded in three; and Liebig's test in one. But the liquid in the watch-glass used for this test was found to have been whitened by the sulphide of ammonium, and, on being evaporated, yielded a white stain, having a distinct and characteristic reaction with the per-salt of iron.

Hydrocyanic Acid in Organic Mixtures.

The acid being highly volatile, the examination of organic liquids supposed to contain it, should on no account be delayed; and the same precaution should be observed in reference to post-mortem examinations, and the analyses which may arise out of them.

For the detection of hydrocyanic acid in organic mixtures, nitrate of silver cannot be immediately employed, as it yields a white precipitate with hydrochloric acid, of which there is always some in the contents of the stomach, as well as with the salts of that acid, such as common salt. We must therefore resort to a process of distillation. But previous to doing so, we may advantageously apply the four tests already described to the vapour given off by the organic substance. The process of distillation is to be conducted as follows:—

The filtered liquid, if alkaline, is neutralized by sulphuric acid, which will fix any ammonia generated by putrefaction. It is then to be distilled from a water-bath, at a temperature of about 150°, till about an eighth part has passed into the receiver. This distilled fluid may then be tested by the reagents just described.

It has been objected to this, and every other process in which heat is employed, that hydrocyanic acid may be formed during distillation by the decomposition of animal matter. This is a mere conjecture, altogether unsupported by experiment. It has also been objected that the acid may be formed in the course of the putrefaction and decay of various animal and vegetable matters, such as cheese and the ergot of rye.

These objections are futile in all those cases in which persons are found dying or dead with the odour of prussic acid strong upon them; and in many cases they are effectually removed by analysing the secretions of the body itself, such as the serum of the brain. In a case which I saw during my pupilage, hydrocyanic acid was readily detected by its odour in all parts of the body, and was found in the brain by Mr. Everett.

Quantitative Analysis.—Use for this purpose the precipitated cyanide of silver, every 100 grains of which correspond to 20·33 grains of the pure anhydrous acid.

EXPERIMENTS ON ANIMALS.

Hydrocyanic acid in all its forms is a most energetic poison. Animals made to breathe air saturated with the vapour of the anhydrous acid, die instantaneously (Pereira), or in from one to

ten seconds (M. Robert). In the fluid form the anhydrous acid is scarcely less rapid in its action. A single drop put into the throat of a dog killed the animal after two or three deep hurried respirations; it caused death almost as quickly when dropped under the eyelid; and when injected into the jugular vein, the animal fell dead at the very instant, as if struck with a cannon ball, or with lightning (Magendie).

A single drop in the mouth of a rabbit began to act in sixty-three seconds, and killed it in eighty-three; three drops began to act on a cat in ten seconds, and on another in five, killing the first in thirty seconds, and the second in forty; four drops began to act on a rabbit in twenty, and killed it in thirty, seconds; and a quantity equivalent to an ounce and a half of medicinal acid, began to act on a rabbit directly it was poured into its mouth, and killed it outright in ten seconds at furthest. Three drops projected into the eye, acted on a cat in twenty seconds, and killed it in twenty more, and the same quantity dropped on a fresh wound in the loins, acted in forty-five seconds, and proved fatal in a hundred and five. In the slower cases, there were violent fits of tetanus; but in the very rapid cases the animals perished just as the fit began to show itself with retraction of the head. In rabbits the spine was bent back, in cats it was curved forwards. (Christison.)

The concentrated acid, then, according to its quantity, and mode of administration, may begin to act on the animals usually submitted to experiment instantaneously, or in from five to sixty-three seconds, and may kill in from ten to one hundred and five. When dropped into the mouth it may begin to act in from five to ten, and prove fatal in from thirty to forty, seconds.

The effects of the dilute acid on animals have been reported by several observers. Mr. Nunneley, of Leeds, to whom we are indebted for a very large and carefully conducted series of experiments, mostly on dogs, shows that a large dose of the dilute acid kills as quickly as the concentrated acid; and that moderate dilution not only does not impair, but even somewhat enhances its effects. Large doses of the dilute acid destroy life in from two to fifteen minutes; but life may be prolonged, after a fatal dose, for hours or even days. A dog poisoned by Coullon died after nineteen days of suffering.

When the dose is short of a fatal one, the animal is seized in one or two minutes with giddiness, weakness, salivation, and protrusion of the tongue, hurried, panting respiration, livid face, and protrusion of the eyes, with convulsions or tetanic spasms, passing into paralysis, and insensibility. After lying in this state some

time, sensibility and power of motion are gradually restored, with slight convulsions and gasping respiration, and sometimes with strong convulsions and loud howlings. The animal then falls into a sleep, sometimes so profound as to resemble the effects of opium, and wakes up recovered but feeble. The breath of the animal has the odour of the poison.

Several questions of obvious medico-legal importance relating to the symptoms of poisoning by prussic acid have been illustrated by experiments on animals. These will now be briefly indicated.

Convulsions.—The question, whether convulsions are among the common symptoms of poisoning by prussic acid, is one of some importance. It has been answered in the affirmative. Convulsions are generally present; but exceptions to the rule are not infrequent, and are recorded by almost all who have experimented largely on animals.

The Shriek or Cry.—This too is a common, but not constant, symptom. It is described by Mr. Nunneley as "a peculiar cry, indicative of severe distress, different from anything heard in any other state," and as he believes "characteristic of the poison." This cry has been frequently reported as absent, and in Mr. Nunneley's numerous experiments on dogs was present only in one-half the cases.

Expulsion of Fæces and Urine.—In Mr. Nunneley's experiments, the fæces alone were passed in about a tenth of the cases; in another tenth both fæces and urine; in a far larger number the urine alone; and in about two-fifths of the whole neither fæces nor urine.

Acts of Volition.—Some of the subjects of Mr. Nunneley's experiments performed acts of volition before the poisonous effects showed themselves. One dog, after taking the poison, "went down three or four steps of some stairs, saw the door at the bottom was closed, and came back again;" and another "went down, came up, and then went down again the whole flight of a steep winding staircase;" and a third "retained sufficient vigour to jump over one of the dogs, and then actually leaped completely across the open top of the staircase."

The *post-mortem appearances* in the animals submitted to experiment have not been well marked. The brain has generally a natural appearance, though its vessels have been found turgid, and in one instance (in the horse) there was extravasation of blood between its external membranes. The heart and great vessels differ in their condition, and in their contents, according as death occurs quickly or slowly. In cases of sudden death, the left side of the heart is, in almost every case, perfectly empty and

rigidly contracted, while the right contains blood, sometimes in large quantity. In chronic cases, both sides of the heart are distended with black blood (Nunneley). Sometimes the blood is florid, and sometimes, though usually fluid, coagulated. According to Magendie, the pure acid so completely destroys the irritability of the heart and voluntary muscles, that they are insensible even to the stimulus of galvanism. But in the experiments of Christison and others, it was found to occur only in some instances. "In eight experiments on cats and rabbits with the pure acid the heart contracted spontaneously, as well as under stimuli, for some time after death, except in the instance of the rabbit killed with twenty-five grains, and one of the cats killed by three drops applied to the tongue. In the last two the pulsation of the heart ceased with the short fit of tetanus which preceded death; and in the rabbit, whose chest was laid open instantly after death, the heart was gorged, and its irritability utterly extinct." The lungs are sometimes empty, but more frequently gorged with blood. The membrane to which the acid is applied is usually found congested. The corpse is generally very rigid.

SYMPTOMS, MORBID APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms of poisoning by prussic acid in the human subject vary, as experiments on animals would lead us to expect, with the dose, and with the age, strength, and state of the patient. When the dose is large, the symptoms begin in a few seconds or minutes. There is probably, in all cases, a short interval of consciousness, and then a sudden access of giddiness, rapidly followed by insensibility, deep catching respiration, and speedy death. When the case is prolonged beyond a few seconds, or minutes, other symptoms are superadded.

The symptoms of the fatal cases and those of greatest severity are:—insensibility, deep catching respiration, loud mucous rattle, cold and blue skin, dilated pupil, very rapid pulse and breathing, rigid contraction of the jaw, tetanic spasms or strong convulsions of the extremities, and, in some cases, discharges of urine and fæces. In protracted fatal cases, and in rare cases of recovery, the leading symptoms are dyspnœa, loud mucous rattle, slight convulsions, and salivation. In acute cases, the cause of death is shock, in chronic cases, suffocation. In rare instances narcotic symptoms are present, as in poisoning by opium.

The short interval of consciousness which, as just stated, probably occurs in all cases, is sometimes filled in by voluntary acts. But a few persons, after swallowing large doses, have staggered a few steps, fallen without a groan, apparently lifeless, and died

after a few convulsive expirations, in less than four minutes after swallowing the poison; others have uttered expressions of fear, and then fallen as if struck by lightning. In many cases they have been heard to fall without uttering any sound.

In smaller doses, the poison occasions nausea, salivation, followed sometimes by ulceration of the mouth, a rapid pulse, and weight and pain in the head, succeeded by a feeling of anxiety lasting several hours.

Post-mortem Appearances.—The countenance is pale and composed, the eyes glistening, the venous system gorged with blood of a glimmering blue tint, the brain congested, with serous effusion into the ventricles. Traces of inflammation, or of congestion, of the mucous membrane of the stomach, in patches or spots, congestion of the lungs, and a deep blue colour of the bile, have been mentioned among the occasional post-mortem appearances. Putrefaction makes rapid progress, as in most other forms of sudden death.

The stomach and every part of the body exhale the odour of prussic acid; but not in all cases. It may be expected to be absent in those cases in which the patient survives long enough to exhale it freely from the lungs, or where the body has been for some time placed under circumstances favourable to evaporation. It has been recognised in the stomach, and not in other parts of the body; and, on the other hand, in other parts when there was no trace of it in the stomach. The odour is most conclusive when perceived in the blood or limbs; for it has been asserted occasionally to exist in the stomach and intestines, and in the brain, where no substance containing prussic acid has been taken.

Treatment (*Antidotes*).—Chlorine and the mixed oxides of iron are antidotes to prussic acid. The one acts by withdrawing the hydrogen of the poison, the other by forming with it the insoluble Prussian blue. But there are few cases in the human subject in which an antidote can be applied, and none in which the preparation of an antidote would not be a loss of valuable time. In the great majority of cases the medical man is called to a suicide already dead, or *in articulo mortis;* and when the patient is still alive, the jaw is so firmly closed as to render the introduction of an antidote very difficult, if not impossible.

The first step to be taken is to administer the *cold affusion* as a shock, by water dashed into the face, or freely poured on the head and back. As soon as the patient is roused, though still insensible, and perhaps in convulsions, the face and trunk must be wiped dry, the clothes removed, and the patient placed in bed. An attempt may now be made to pass a feather to the

back of the throat to promote vomiting. A sponge or rag sprinkled with disinfecting fluid, may now be held to the nostrils, and the surface must be kept warm by hot cloths or flannels, and by frictions with the hand or flesh-brush. As soon as the jaws can be opened, and the patient be made to swallow, an emetic of sulphate of zinc, of mustard, or of common salt, should be given; or the stomach-pump may be employed.

Fatal Dose.—This may be stated for the adult at somewhat less than a grain of the pure acid, or about 45 minims of the acid of the British Pharmacopœia. Very severe symptoms have been caused by about half a drachm of this acid, but recovery has taken place from doses of seventy or eighty drops.

Commencement of the Symptoms.—There are no cases on record of that instantaneous action in the human subject which has been noted in experiments on animals. But when the dose of the acid is large the symptoms set in very soon, and death quickly follows. In a case reported by Hufeland a quantity equivalent to forty grains of the pure acid was taken. The man was seen to swallow the poison, was observed to stagger a few steps, and then to sink down without a groan, apparently lifeless. When, therefore, the dose is very large, the symptoms manifest themselves almost instantaneously. But after smaller fatal doses, or doses productive of severe effects, a short interval elapses between the taking of the poison and the loss of sense and power. The voluntary acts that can be performed in this interval will be presently ascertained by an appeal to recorded cases.

Fatal Period.—After a large dose, death takes place in from two to five minutes. But it may not happen till twenty minutes, half an hour, three quarters of an hour, or an hour; and patients may continue in imminent danger for several hours, and yet recover.

Voluntary Acts.—The question whether, after taking a large dose of prussic acid, the patient retains his consciousness for a time, so as to be able to perform certain voluntary acts? may become important. In favour of the retention of consciousness I have the distinct statement of the patient whose case will be presently cited; and that many voluntary acts may be performed in this conscious interval is proved by several recorded cases. The medico-legal import of the question will be understood from the following case:—

An apothecary's maid-servant at Leicester, pregnant by Freeman, her master's apprentice, was found dead in bed, poisoned with prussic acid. The apprentice was suspected of having been accessory to her death; but, as it was proved that

the deceased had made preparations for effecting a miscarriage, she might have taken the poison of her own accord. The question of suicide or homicide could be answered only by a reference to the condition in which the body was found. It appeared, from the evidence, that the body lay at full length on the bed, with the head turned a little on one side, the arms crossed over the trunk, and the bed-clothes pulled smoothly up to the chin; under the clothes, on her right side, lay a corked phial, wrapped in paper, and containing three drachms and a half of the poison. The leather and string which had fastened the cork were found in the chamber-vessel.* It was probable, therefore, that four and a half drachms of the poison had been swallowed; and the question arose, Could the girl, after taking this quantity of the poison, have corked the bottle, wrapped it up, and adjusted the bed-clothes?

This question can be answered only by an appeal to fatal suicidal cases in which similar acts of volition have been performed; or by comparing the time which such acts occupy, with ascertained intervals of consciousness in the human subject. The experiments on animals performed by some of the medical witnesses examined in this case, though useful as illustrations, are quite inconclusive.

The following facts may be cited in illustration of the question raised in this case:—An apothecary's assistant in Germany took four ounces of the acid of the Bavarian Pharmacopœia, and was found dead in bed, with an empty two-ounce phial on each side of the bed, the bed-covering pulled up as high as the breast, the right arm extended beneath it, and the left arm bent at the elbow. In a suicidal case reported by Mr. Newham, the bed-clothes were smoothly drawn up to the shoulders; and on a chair close to the back of the bed was a phial with the cork in it. A third case of the same kind was communicated to Dr. Taylor by a pupil. A man found dead on the seat of a water-closet, had the bottle from which the poison was taken corked in his pocket. In a curious case of double suicide reported by Dr. Letheby, the bodies were found in positions which implied a succession of slight voluntary movements.

These facts prove the possibility of slight voluntary efforts being made after a large dose of prussic acid; and they justify, as far as this question is concerned, the verdict of acquittal pronounced in favour of Freeman.

But the voluntary acts that may be done after fatal or highly dangerous doses of this poison go much beyond those inferred

* See this case very fully reported, 'Medical Gazette,' vol. viii. p. 759.

from the position of the bodies in these instances. They may be more numerous and more considerable. In the suicidal case presently to be more minutely described, as one of recovery after six hours of imminent danger, a large dose of the poison was taken in bed; but the lad was able to get out of bed, to walk round the foot of it to a chest of drawers at a distance of two or three yards, to place the stopper firmly in the phial, and to return to the side of the bed whence he fell senseless.

In another class of cases the suicide, in addition to other movements implying volition, has been able to cry for help and even to converse.

An apothecary's apprentice sent from the shop to the cellar had only been a few minutes away when he was heard to cry, in great alarm, "Hartshorn! hartshorn!" On rushing downstairs, his companions found him lying on the lower step, grasping the rail; and he had scarcely time to mutter, "Prussic acid!" when he died, not more than five minutes after leaving the shop. He had taken a drachm of the Bavarian acid, had tried to get at the ammonia, but had not strength to uncover the bottle.

In two cases reported by Mr. Nunneley, of Leeds, the patients not only moved about, but spoke and answered questions, after taking, the one a fatal, the other a large dose of the poison. The subject of the first case answered a question some minutes after he had taken the poison, and the man who recovered retained the use of speech till the jaws gradually closed.

A very remarkable case illustrating the power of locomotion and of speech after a fatal dose of the poison is recorded by Dr. S. C. Sewell, of Montreal. A hypochondriac gentleman, having locked himself in his room, took seven drachms of prussic acid of the estimated strength of three per cent., but after about a minute he unlocked the door, and cried out, "Come to me quick, I am dying." A servant immediately entered the room, and found him lying on his back on the sofa, with his legs crossed, insensible, and snoring. Dr. Sewell arrived in twenty minutes. He was then dead, and presented the appearance of profound slumber; legs crossed, arms by his sides, and eyelids firmly closed.*

The effects of prussic acid taken in a large, but not fatal, dose will be seen by the two cases which follow. The first is described in the 'Revue Médicale' for February, 1845, the second came under my own observation in the previous year.

Dr. B——, a physician at Rennes, having taken a teaspoonful

* For full details of some of the cases just cited, and for other cases of poisoning by hydrocyanic acid, refer to Ranking's 'Half-yearly Abstract of the Medical Sciences,' vol. ii. p. 399.

of prussic acid, prepared by himself, in the morning, without inconvenience, took another, prepared after Scheele's method, after dinner. These two doses produced no marked effect. He then took a third teaspoonful of a preparation purchased of M. Vauquelin, and after an interval of a few seconds, another. This new preparation tasted a little stronger, but Dr. B—— remarked that "it had not hurt him." But on walking out of the shop in which he made the last experiment, he felt an alarming disturbance in his head, and on returning, uttered a few expressions of fear, and fell down as if struck by lightning. The teeth were, at this time, firmly closed, there was continually-increasing dyspnœa, with noisy and rattling respiration, cold extremities, distortion of the mouth, redness and swelling of the face and neck, fixed and dilated pupil, and a pulse imperceptible in the left, and very small in the right arm. The trismus became more marked, a short and violent convulsion ensued, and the abdomen, especially about the epigastrium, became rapidly distended. Attempts were now made to rouse him by stimulant frictions with ammonia and cantharides, and by other stimulant applications. Vomiting was also excited by tickling the throat with a feather, and some dark-coloured mucus discharged. After remaining in this state for two hours and a half, he began to show signs of returning consciousness, and recognised those around him. The intellectual faculties were gradually restored, but considerable difficulty of breathing and very distinct rattle remained, with occasional expectoration of yellowish black mucus. During the whole of this time the breath smelt strongly of prussic acid. Dr. B—— was thirteen days before he could go out to see his patients, during which time the dyspnœa was frequently distressing, particularly when he turned in bed, and when he awoke in the morning. At last he quite recovered. During the first four days very little urine was passed.

In the month of November, 1844, I was called up at night to see a young gentleman who had swallowed prussic acid. The particulars of the case, as detailed by himself and his relatives, are as follows:—

He is the son of a medical man, is about nineteen years of age, and studying the law. His disposition is naturally cheerful; he has met with no disappointment; and never, till the present attempt, had contemplated suicide. His habits are temperate and industrious. On the afternoon of the day on which he swallowed the poison he dined in the Hall of one of the Inns of Court, and drank, according to his own account, half a bottle of wine—a quantity much exceeding what he was in the habit of

taking. On reaching home he was observed to be somewhat affected by liquor, and before going to bed went into the surgery, from which he took a stoppered bottle containing, according to the estimate of his father and the apprentice, from one to two drachms of prussic acid of Pharmacopœial strength, but according to his own statement, about a mouthful. Soon after he had gone to bed the family was startled by a noise in his room as of a heavy body falling, and a relative, who was passing at the time, was alarmed by a loud gurgling noise. His father was almost immediately on the spot, and seeing the bottle on the drawers, dashed several buckets of water over the face and chest. This roused him. He was then taken into an adjoining room, and put to bed, the treatment consisting in holding ammonia to the nostrils, and applying heat to the spine and feet. An injection was also given, containing tincture of assafœtida.

When I reached the house I found him in the following state, in which he had continued without alteration for three hours:—He lay on his back, drawing in his breath with great effort, and a loud gasping sound, with a distinct mucous râle. The pulse was upwards of 140 in a minute, and the respiration 36. The surface was very cold; the countenance of a dull leaden hue; the lips blue; the pupil extremely dilated; and the jaws rigid, in which state they had remained for the whole period, so that it had been impossible to administer any antidote.

The treatment from this time forward consisted in ammonia to the nostrils, assiduous frictions with the flesh-brush, and the application of heat to the surface by means of flannels warmed at the fire, and constantly renewed. At the expiration of about five hours there was some effort to vomit, encouraged by tickling the throat, and some bloody mucus was wiped from the mouth. Soon afterwards he could be made to swallow, when some warm brandy and water and strong coffee were given him. At this time, too, he could answer in monosyllables, and raise himself on his elbows. He was also perfectly sensible, but looked bewildered. At the end of about six hours he was sufficiently recovered to answer questions, move himself about, and call for lemonade, which he drank freely. The mucous râle had disappeared, the respiration and pulse were still frequent, the pupil was restored to nearly its usual size, and the skin was warm. Being disposed to be quiet, and seeming out of danger, he was left to himself. After a time he complained of fulness at the stomach, and asked for an emetic, which brought off his stomach a large quantity of undigested food.

I saw him again about fourteen hours after taking the poison,

and found him quite well, though weak. He gave the following distinct account of the attempt of the night before:—He was suddenly tempted, as he said, by the devil, to take prussic acid, under a confused idea that it would not hurt him. He swallowed a mouthful of the acid from the bottle in bed. He then got out of bed, walked round the foot of it to a chest of drawers standing within a few yards of the bedside, placed the stopper so firmly in the bottle that it could not be removed, and then walked back to bed, intending to get in again, but sat down upon it, and then lost all consciousness. During all this time he said that he had no giddiness, nor unpleasant sensation of any kind, no more than if he had taken so much water. He also assured me, and his manner made me quite confident that he spoke the truth, that the idea of suicide had never before entered his head. The father of the lad afterwards told me that the fæces, and, as he believes, the urine too, were expelled as the first effect of the poison.

On examining the bottle which had contained the prussic acid, it was found quite empty, so that it was not possible to ascertain the strength of the preparation. From the statement of the father and apprentice, that the bottle contained one or two drachms, and that of the lad himself, that he had swallowed a mouthful, it is highly probable that the dose taken was such as to prove fatal had it not been for the prompt application of the cold affusion, the continued use of ammonia, and the assiduous application of warmth to the surface. When I first saw the patient the remedies most strongly indicated were warmth and friction to the surface, of which the first had been already applied, but to an insufficient extent. The extreme coldness of the surface, the blueness of the hands and face, the labouring respiration, and the abundant collection of mucus in the air-passages, rendered such treatment imperative.

This case is specially interesting as showing the interval of perfect consciousness and complete command of the muscles which may intervene between the swallowing of a large dose of prussic acid and the development of the characteristic effects of the poison; and it is a very striking example of a large class of cases of suicide in which the impulse to the commission of the act precedes the act itself by a very short interval, and springs up during a temporary excitement of the mind.

Three medico-legal questions which have been raised in cases of poisoning by prussic acid have still to be considered. To two of these questions some importance was attached in the case of Sarah Hart, the victim of Tawell. 1. Is there, in cases of poisoning by prussic acid, any death-cry or scream which would

serve to announce the operation of the poison? 2. Are convulsions of common or of universal occurrence? 3. Is prussic acid a cumulative poison? 1. In answer to the first question it may be stated that a patient who is conscious of having swallowed the poison may call out for assistance: but the plaintive cry, or louder scream, sometimes heard in animals has not yet been recorded in any case of poisoning in man. 2. It is probable that convulsions are not of more frequent occurrence in poisoning by prussic acid than in other cases of sudden death. The expulsion of the urine and fæces, observed in certain cases, was probably accompanied by short convulsions, and in some cases (as in one reported by Mr. Hicks) there have been efforts expressive of intense anxiety and urgent want of breath; but the deliberation which has characterized the few movements of the patient, and the calm and easy attitude of the dead body in almost every instance, show that convulsions are either absent altogether or short and transient. 3. The question of the cumulative property of prussic acid may be raised when a patient dies while taking a series of medicinal doses of the acid at intervals of a few hours. It is deemed probable that the previous doses have not been eliminated from the system, or spent their force upon it, and that the addition of the last dose determines the fatal result. In the case of so volatile a poison, and one so readily eliminated, it seems highly improbable that a medicinal dose, which is generally but a small fraction of the smallest fatal one, or even a series of such doses, would leave such a residual effect as to prove fatal on the addition of another medicinal dose. But doses that exceed the proper medicinal limit may happen to prove fatal, though similar previous ones have appeared to be harmless, in consequence of a change in the state of the body itself; for there is no doubt that the line which divides a harmless from a fatal dose is not very wide. Fortunately this question, so difficult of solution, is not one of great practical importance.

POISONING BY THE CYANIDES.

The cyanides of potassium and of mercury have proved poisonous, the latter with symptoms allied to those of poisoning by corrosive sublimate (see p. 470), the former with symptoms of poisoning by the acid itself.

Cyanide of Potassium.—This substance is now largely used in the arts, both in electrotyping and in photography. It is used to remove stains of nitrate of silver from the hands, and to clean tarnished metal and gold and silver lace.

Properties.—This salt is sold as a deliquescent white crystal or

crystalline mass, which gives out a strong odour of prussic acid, and has a characteristic cold, bitter, pungent taste. It is very soluble in water; and its solution has a strong alkaline reaction.

Tests:—a. On adding an acid, the vapour of prussic acid is given off, which may be identified by its odour, and by the tests described at p. 574. *b.* It yields with a solution of nitrate of silver the white cyanide. *c.* Chloride of platinum throws down the base. *d.* The liquid tests produce with the solution the reactions described at p. 573; but as the solution already contains potash, the addition of liquor potassæ is not needed.

In *organic liquids* the poison may be detected by neutralizing the base with sulphuric acid, and immediately distilling over the prussic acid.

Symptoms.—This substance acts nearly with the rapidity and violence of prussic acid itself, and produces symptoms differing so little from those proper to the acid as to require no separate description.

Fatal Dose.—Less than five grains. From the composition of the cyanide, which contains nearly 40 per cent. of the anhydrous acid, it is probable that about two and a half grains of this salt would destroy life.

Post-mortem Appearances.—Those proper to poisoning by prussic acid.

Treatment.—That of poisoning by prussic acid itself. As the cyanide is a strong irritant, it should be applied to the hands to remove stains with caution, and used with like care for manufacturing purposes.

VEGETABLE SUBSTANCES AND PRODUCTS CONTAINING, OR YIELDING, HYDROCYANIC ACID.

The leaves, seeds, or roots of several plants either contain prussic acid, or yield it when bruised and moistened. The bitter almond, the kernels of the cherry, plum, and peach, and the pips of the apple, are examples of poisonous seeds; the leaves of the cherry laurel yield the poison on distillation, and the plant which yields tapioca (the *Iatropha manihot*, or cassava) contains prussic acid in the juice of the root. The bitter almond, the oil and water obtained from it, and the water distilled from the cherry laurel, are particularly deserving of notice.

The bitter almond is distinguished, as its name implies, by its bitter taste. It forms with water a white emulsion, in which the essential oil blended with prussic acid is rapidly developed by the mutual action of two of its constituents, *emulsine* and *amygdaline.* The vapour from the emulsion acts characteristically with the tests for prussic acid. As the same change takes place in the

stomach, bitter almonds cannot be safely eaten in large numbers, and the same is true of the *bitter almond cake*, which remains after the expression of the fixed oil. But the essential oil, its alcoholic solution (almond flavouring), and bitter almond water, are active poisons, and have proved fatal. Of these three preparations the essential oil is by far the most important, as it is a very active, and has now become a very favourite, poison.

Essence or *Oil of Bitter Almonds.*—This is the product of the distillation of the pulp or emulsion of the bitter almond. It contains, in addition to hydrocyanic acid, hydride of benzole, benzoin, and benzoic acid. The hydrocyanic acid, to which it chiefly owes its poisonous properties, may be separated from it, and the essence thus purified, and rendered comparatively harmless, is sold for culinary purposes. The essence, or oil, previous to this separation, contains from $8\frac{1}{2}$ to $14\frac{1}{2}$ per cent. of the anhydrous acid. It is, therefore, from four to seven times as strong as the acid of the Pharmacopœia. A liquid variously known as almond flavour, spirit of almonds, or essence of peach kernels, consists of the oil dissolved in seven or eight times its quantity of spirit.

Properties.—Ordinary specimens of the oil have the colour of amber, a peculiar, pungent odour, due in part to the prussic acid which it contains, and a bitter, aromatic taste. It is heavier than water, which dissolves only a small fraction of it; but it is soluble in alcohol and ether. It produces a greasy stain on paper, and has a slight acid reaction. Strong sulphuric acid reddens it.

Tests.—Those of hydrocyanic acid. Pour drops of the oil into a series of watch-glasses, add a few drops of distilled water, and invert over them disks of glass moistened with the several tests (p. 574). The vapour acts more promptly when the glasses are warmed. Or, place a few drops of the oil in a test-tube, add a drachm of distilled water, mix them well by shaking; pour the mixture on a wet filter, and test the liquid that passes through as for dilute hydrocyanic acid.

Symptoms.—Those of poisoning by hydrocyanic acid (p. 579); but the symptoms appear to begin later, and last longer. The recorded cases present similar variety, and similar acts of volition occupy the interval between swallowing the poison and the commencement of the symptoms.

Post-mortem Appearances.—Those of poisoning by prussic acid (p. 580), the odour of the oil taking the place of that of the acid.

Treatment.—That of poisoning by hydrocyanic acid (p. 580).

Fatal Dose.—About twenty drops. As strong specimens of the oil have from four to seven times the strength of the acid of

the Pharmacopœia, and a less quantity of the acid than fifty minims has proved fatal, it is probable that ten or twelve drops might kill an adult.

Duration.—From a few minutes to half an hour. It may destroy life as speedily as prussic acid itself.

Bitter Almond Water.—This water is distilled from the cake left after expressing the fixed oil. It is found in the shops of very variable strength; some specimens containing one per cent., others a quarter per cent. It is quite unfit for medicinal uses. It owes its poisonous property to the prussic acid which it contains; and responds to the tests for that poison (p. 573). The symptoms, post-mortem appearances, and treatment are those of poisoning by the acid (p. 579).

Laurel Water.—The leaves of the cherry laurel (*Prunus lauro-cerasus*), fig. 161, yield both a distilled water and an essential oil, which have the same properties as the water and oil of bitter almonds, and were formerly employed for the same purposes. The quantity of prussic acid in the water is about a quarter, and in the oil three and a quarter, per cent. Other portions of the plant also yield the poison; but it is not contained in the pulp of the fruit. The cherry-laurel water has more than once proved fatal; but the case which possesses the greatest interest is that of Sir Theodosius Boughton, poisoned by Captain Donellan in 1781.

Fig. 161.

Sir Theodosius Boughton, a healthy young man twenty years old, was in the habit of taking a laxative draught from the hands of his mother. On the morning of his death she observed, while giving him his draught, that it had a strong smell of bitter almonds. "Two minutes after he took it she observed a rattling or gurgling in his stomach; in ten minutes more he seemed inclined to doze, and in five minutes afterwards she found him quite insensible, with the eyes fixed upwards, the teeth locked,

froth running out of his mouth, and a great heaving at his stomach, and gurgling in his threat. He died within half an hour after swallowing the draught." The body was carelessly inspected ten days after death, but the post-mortem appearances threw no light on the cause of death. The odour of the draught, the rapid occurrence of symptoms so closely resembling those present in recorded cases of poisoning by prussic acid, and the speedy death of the sufferer at an age when apoplexy is so rare, combine to leave no reasonable doubt of the real cause of death.

II. OXALIC ACID (*Acid of Sugar*).

This substance is largely used in the arts, under the name of acid of sugar. It is in use by bookbinders, shoemakers, and workers in leather, by straw-bonnet makers and workers in straw; and by workers in brass; also to take ink-stains out of linen. It is sold both by druggists and by persons who supply the trades using it. Its cheapness (2*d*. per ounce), common employment, and known activity, commend it to the suicide; its resemblance to Epsom salts leads to accidents; but its sharp sour taste unfits it for the purpose of the murderer, unless mixed with some strongly-flavoured liquor, such as gin, brandy, or rum, or strong tea or coffee.

Oxalic acid takes the sixth place among the ascertained poisons. In the five years, 1852--56, it was credited with 13 deaths per annum, or about 1 in 21 of the ascertained poisons. Of these 13 deaths, 4 occurred in men and 9 in women, and 10 of the 13 were suicidal cases.

Oxalic acid may have to be examined in substance, in solution, and in organic mixtures.

1. *In Substance.*

The crystals are transparent, colourless or nearly so, not deliquescent, very sour in taste, soluble in their own weight of hot, and in about eight times their weight of cold water; also in alcohol. When heated on platinum foil, they are wholly dissipated. When heated on a plate of white porcelain, they yield a white sublimate at 180°, and melt at 280° Fahr.

They are flattened four-sided prisms, with dihedral or tetrahedral summits (fig. 162); and, when deposited from solutions of the acid, the forms shown in fig. 163. They bear such a resemblance to the crystals of sulphate of magnesia and sulphate of zinc, as to be occasionally confounded with them.

Fig. 162.

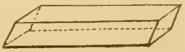
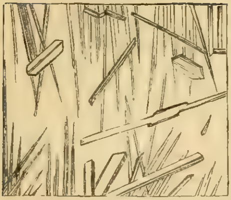


Fig. 163.



Solution $\frac{1}{100}$.

The distinction, however, is easy. Oxalic acid has a sharp sour taste; the two salts are bitter: the solution of oxalic acid has a strong acid reaction; that of sulphate of magnesia is neutral, and that of sulphate of zinc only slightly acid: oxalic acid is entirely dissipated by heat, or, if impure, leaves only a scanty residue; the two salts are fixed: liquor potassæ added to a solution of the acid produces no change; but it precipitates the white oxides of the sulphates of magnesia and zinc: the acid effervesces with solutions of the alkaline carbonates, but yields no precipitate, while the sulphates of zinc and magnesia give a white precipitate, without effervescence. Oxalic acid discharges the colour of ink; the other crystals do not. It is sufficiently distinguished from the citric and tartaric acids by the defined shape of its crystals.

2. *In Solution.*

The liquid is known to contain an acid by its action on litmus, and a vegetable acid or acid salt if it yields crystals on evaporation. Long slender prisms, dissipated by heat, afford a strong probability of the presence of oxalic acid. The absence of precipitate with nitrate of baryta shows that it is not sulphuric acid. On the addition of nitrate of silver a white precipitate is thrown down.

If we have reason to believe that the liquid contains oxalic acid, we may confirm our suspicion by evaporating and obtaining crystals (fig. 163), or by the addition of ammonia, which, in strong solutions, produces characteristic radiated crystals of oxalate of ammonia. The characteristic tests by which the acid may be fully identified are the following:—

1. *Nitrate of Silver.*—It throws down an abundant white precipitate of oxalate of silver, soluble in nitric acid and ammonia; and which, when dried and heated on platinum foil, detonates, and is dispersed as a white vapour, consisting of finely divided metallic silver.

2. *Sulphate of Lime.*—The salts of lime in excess give with oxalic acid a white precipitate, soluble in nitric and hydrochloric acids, but insoluble in the vegetable acids and in ammonia.

Sulphate of copper yields with oxalic acid a greenish-white precipitate of oxalate of copper. The soluble salts of lead also

give a white precipitate—a fact of which we avail ourselves in the process for organic liquids.

3. *In Organic Liquids.*

As oxalic acid is not altered by contact with the animal textures or with food, and an antidote can rarely be given, the process for the free acid is comparatively simple.

The acid liquid if dilute may be filtered at once, but if not, we add distilled water, allow the liquid to stand for a time, filter, and concentrate by evaporation. To the resulting liquid we add acetate of lead till a precipitate ceases to be formed. This precipitate, the oxalate of lead, is then diffused through distilled water, and sulphuretted hydrogen gas transmitted through it for two hours. Black sulphide of lead is thrown down, and oxalic acid is set free. The sulphide having been separated by filtration, the acid remains in solution.

If the carbonate of lime or magnesia had been employed as an antidote, we should have to adopt a modified process to detach the acid from the base. The solid matters must first be broken down, and the mixture brought to the consistence of a thin syrup by the addition, if necessary, of distilled water. About a twentieth part of its bulk of carbonate of potash must then be added, and it must be boiled for two hours. The resulting liquid will contain soluble oxalate of potash, and insoluble carbonate of lime or of magnesia. The insoluble matters being now separated by filtration, the liquid which passes the filter will consist of oxalate of potash in solution. The alkali is now to be neutralized with pure nitric acid, and the solution of acetate of lead to be added as long as any precipitate falls. The oxalate of lead is to be collected as before, and suspended in distilled water. The oxalic acid separated by sulphuretted hydrogen may be identified by the tests already described.

If the antidotes have only partially neutralized the oxalic acid, so that the liquid has an acid reaction, the first process must be adopted for the liquid portion, and the second for the solid matters.

As oxalate of lime exists in large proportion, but in small absolute quantity, in rhubarb, it is always possible to attribute its detection, when in small quantity, to rhubarb taken medicinally. The history of the case, with the previous symptoms and post-mortem appearances, will at once meet this objection.

A strong solution of oxalic acid stains black cloth a deep-brown colour without corroding it, and it reddens the vegetable blues.

As it removes the colour of ink, it has been used to discharge writing.

Quantitative Analysis.—Use for this purpose the oxalate of lead. A hundred grains correspond to forty-two of the crystallized acid.

Experiments on Animals.—Large doses (such as ʒss) in strong solution cause symptoms of irritant poisoning, and death from collapse in from two to twenty minutes. Black extravasated blood is found in the stomach, and there are marks of acute inflammation, with hardening or softening of the lining membrane. The diluted acid in large doses kills by paralysing the heart; in lesser doses by tetanic spasm of the muscles of respiration; and in still smaller ones by coma.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms in man vary with the dose and the concentration of the poison. When the dose is large, and the solution strong, the symptoms follow immediately on the swallowing of the poison. An intensely sour taste is speedily followed by a burning sensation in the pit of the stomach, increased by pressure, with pain and constriction of the throat. Vomiting, sometimes of blood, but generally of a greenish-brown or black grumous matter, soon follows, and, if the patient survive several hours, there is purging of a similar matter, sometimes tinged with blood. The remaining symptoms are those of collapse—extreme debility, pale and anxious countenance, cold and clammy skin, small and frequent pulse, and hurried respiration. There are also soreness of the mouth, inflammation and swelling of the tongue, constriction of the throat, painful deglutition, intense thirst, restlessness, difficulty of breathing, and harassing cough. Cramps and numbness of the legs and arms, acute pain in the head and back, delirium and convulsions, are among the nervous symptoms present in certain cases.

These symptoms are subject to many anomalies and exceptions. Even pain and vomiting have been altogether absent, or vomiting has not occurred till emetics were administered. An eruption has in one case appeared on the skin. Leeches applied to the epigastrium in a case of poisoning by oxalic acid, soon fell off dead.

Post-mortem Appearances.—The external appearance of the body is natural, and the countenance pale and composed. The lining membrane of the mouth and fauces is generally white, shrivelled, and easily detached; and a similar appearance extends into the gullet, which is contracted into longitudinal and transverse folds, while the epithelium is detached in small irregular

patches, leaving a brown surface beneath. The tube sometimes closely resembles a piece of worm-eaten wood. (See figs. 68 and 69, p. 408.) The stomach contains a dark-brown, or greenish-brown, grumous matter, in appearance nearly resembling *meconium*, which also lines the œsophagus, and extends into the duodenum. In some cases, the lining membrane is quite pale, and free from rugæ; in others it is highly inflamed, and the rugæ strongly marked. It is easily stripped off, and in some instances has been extensively detached. Its vessels are minutely injected with black blood. (See fig. 70, p. 408.) Perforation is rare. In cases of some continuance, the small intestines present the same appearances as the stomach. The peritoneum has been found inflamed, and in one case the right pleura. The lungs are sometimes greatly congested, and in one instance there were some traces of inflammation in the brain.

In rare instances, the most characteristic post-mortem appearances, like the symptoms during life, are absent.

Of the symptoms and post-mortem appearances in poisoning by oxalic acid, Christison justly observes, "If a person, immediately after swallowing a solution of a crystalline salt, which tasted purely and strongly acid, is attacked with burning in the throat, then with burning in the stomach, vomiting, particularly of bloody matter, imperceptible pulse, and excessive languor, and dies in half an hour, or, still more, in twenty, fifteen, or ten minutes, I do not know any fallacy which can interfere with the conclusion, that oxalic acid was the cause of death. No parallel disease begins so abruptly, and terminates so soon; and no other crystalline poison has the same effect."* It may be added, that the post-mortem appearances are scarcely less characteristic. The wrinkled and corroded gullet, the pale, shrivelled, and partially detached mucous membrane of the stomach, the dark veins ramifying on its surface, and the dark-brown grumous matter which fills its cavity, point strongly to the action of a powerful corrosive poison; while the absence of the coloured spots on the skin would preclude the supposition of the effect being due to either of the mineral acids.

* Of 11 cases of poisoning by oxalic acid reported in the Journals, 5 were accidental, and 6 suicidal. Of the accidental cases, 3 were by mistake for Epsom salts. Of 13 cases, 6 recovered and 7 died: 3 occurred in males and 10 in females. The duration of the fatal cases was as follows—2 of a quarter of an hour, 1 of twenty minutes, 1 of less than half an hour, and 1 of eight days. The average duration of the first 4 cases was about twenty minutes.

The reader is referred to the following cases: 'Med. Gazette,' i. 757; v. 704; xxvii. 870; xxxi. 491. 'London Medical Repository,' vi. 474; xi. 20; xii. 18. 'Lancet,' Dec. 15, 1827; vol. ix.; x. 512; xxxii. 748; xxxiii. 29. 'Guy's Hospital Reports,' vii. 353. 'Edin. Med. and Surg. Journal,' xxiv. 67.

First Appearance of Symptoms.—When the quantity of the poison is considerable, and the solution concentrated, the symptoms begin immediately. If the quantity is small, and the solution weak, they may be delayed for some hours.

Fatal Dose.—Less than *half an ounce* has proved fatal (in the case of a lad æt. sixteen, about a drachm); but a smaller quantity has produced severe symptoms, and, on the other hand, recovery has taken place after the administration of two or three times as much. When active treatment is immediately adopted the patient often recovers.

Fatal Period.—Death may take place in less than *ten minutes.* In one case, the subject of an inquest held by Mr. Wakley, it must have been nearly instantaneous. Life has been prolonged to the twenty-third day, the dose having been half an ounce.

Mortality.—The majority of cases prove fatal. A small number recover under prompt treatment.

Treatment.—The proper antidote is chalk, suspended in water. Magnesia or its carbonate may also be used: in the absence of these the plaster of the apartment. Lime water and oil have been used with advantage; but the alkalies are inadmissible. Warm water may be given freely, after the use of the antidotes. If vomiting is not present, emetics of sulphate of zinc may be employed. The stomach-pump should not be used, or it should be introduced with the greatest caution.

BINOXALATE OF POTASH (*Salt of Sorrel—Essential Salt of Lemons*).

This salt is a constituent of wood-sorrel and of other plants. It is used for bleaching straw and removing ink-stains, for which purpose it, or a quadroxalate of potash, is sold under the name of "essential salt of lemons," for three halfpence the half ounce. As a poison it is scarcely inferior in activity to oxalic acid. It has been taken by mistake for the bitartrate of potash, or cream of tartar.

Tests.—The salt consists of colourless rhombic prisms; has a sour taste, and strong acid reaction; and is much less soluble than oxalic acid, requiring forty parts of water for its solution. It resembles oxalic acid in yielding a white precipitate with nitrate of silver and sulphate of lime, and in its reactions with sulphate of copper and the salts of lead.

When the crystals are heated on platinum-foil, they leave a white ash of carbonate of potash, which effervesces with nitric acid, forming nitrate of potash. When they are heated on

a slab of porcelain, they sublime at 280° Fahr., and a superimposed disk of glass bears a sublimate of coarse white crystals.

Symptoms.—Those of poisoning by oxalic acid. In a case of recovery from poisoning by a quarter of a teaspoonful of this substance, reported by Dr. F. C. Webb, there was burning in the throat, a red tongue, intense thirst, no abdominal pain, vomiting after the lapse of two hours, severe pain in the loins, dysuria, great weakness of the legs, pain in the head, and cramps in the hands and legs.

Post-mortem Appearances.—As in poisoning by oxalic acid.

Treatment.—That of poisoning by oxalic acid.

Fatal Dose.—Half an ounce.

Fatal Period.—Eight minutes, in a lady recently delivered.

Mortality.—Like oxalic acid, it has proved fatal in the greater number of cases.

TARTARIC ACID has been taken as a poison in one or two instances.

Tests.—This acid crystallizes in oblique rhombic prisms. It is colourless, and has a pleasant taste; is soluble in five or six times its weight of water, and less soluble in alcohol. When heated, it first fuses, and then burns with a light red flame, giving out a peculiar odour, and leaving an abundant deposit of carbon. It also deposits carbon when heated with strong sulphuric acid.

The solution deposits feathery crystals; yields no distinct precipitate with nitrate of silver; and gives with the salts of potash a white granular precipitate (the bitartrate) in dilute solutions by friction of the sides of the vessel with a glass rod.

Experiments on Animals.—These prove that tartaric is much less active than oxalic acid. In full doses it destroys life in less than an hour, with great weakness, and palsy of the limbs.

Symptoms.—One ounce, dissolved in half a pint of warm water, proved fatal to a young man in nine days, with the ordinary symptoms of irritant poisoning. There are no specific symptoms.

Post-mortem Appearances.—In the case just referred to, inflammation of the greater part of the alimentary canal.

Treatment.—By the same antidotes as oxalic acid, with the after-treatment proper to the class of irritants. The soluble salts of potash are not contra-indicated, as in poisoning by oxalic acid.

CITRIC ACID, as is shown by experiments on animals, is a more active poison than the tartaric. If a case of poisoning should occur by it, the treatment would be that of poisoning by oxalic or tartaric acid.

III. DIGITALIS (*Digitalis purpurea—Foxglove, purple Foxglove*).

This is an indigenous plant, common about banks and hedge-rows, and in pastures, on a gravelly or sandy soil. It is also cultivated for its elegant shape and purple dotted flowers. (Fig. 164.)

Fig. 164.

It belongs to the Linnæan class and order *Didynamia angiospermia*, and natural order *Scrophulariaceæ*, or figworts.

All the parts of the plant are believed to be poisonous, and the leaves have more than once destroyed life.

It owes its poisonous property to the alkaloid *digitaline*, which exists in the fresh leaves in the proportion of less than one per cent. The dried leaves have a place in the British Pharmacopœia; and yield an infusion (30 grains to 10 ounces; dose two to four drachms) and a tincture (two ounces and a half to a pint; dose, ten to thirty minims).

The *root* consists of numerous long slender fibres, and is not likely to be confounded with any of the common edible roots.

The *leaves* are ovate, narrowed at the base, crenate, rugous, and veined, downy, especially on the under surface. The dried leaves have a dull green colour, a faint odour, and a bitter, nauseous taste.

Fig. 165.

The *seeds* are of the small size shown in fig. 165, and weigh about 1126 to a grain. They are of a light brown colour, cylindrical, ovoid, or conical in shape, and, when viewed by the lens or microscope, present the pitted appearance shown in the figure. They resemble the seeds of the Lobelia inflata in colour, but are somewhat larger, and differ widely in microscopic character.

Experiments on Animals.—In moderate doses digitalis causes vomiting, giddiness, languor, and death in twenty-four hours. In larger doses, in addition to these symptoms, tremors, convulsions, stupor, and coma. Injected into the veins, it kills in a few seconds, by acting on the heart and pulmonary circulation. In one of Mr. Blake's experiments, an infusion of three drachms of the leaves injected into the jugular vein arrested the action

of the heart in five seconds, that organ after death being motionless, turgid, inirritable, and its left cavities full of florid blood.

Symptoms.—In the human subject, a single fatal dose produces the following symptoms:—Vomiting, purging, and severe colicky pains in the abdomen; pain in the head, giddiness, and dimness of vision, or actual blindness; a dilated and insensible pupil; a slow, weak, and irregular, or intermittent pulse; nausea and faintness, with occasional syncope; the skin is covered with a cold perspiration; the patient is much worse when he assumes the upright posture. Salivation is a common occurrence. The urine is suppressed; convulsions occasionally occur; and the patient sometimes continues for a considerable space of time in a state of stupor. In two fatal cases death took place in twenty-two hours. When the poison is not fatal, the recovery occupies several days, and the circulation is slowly restored to its usual state.

The *post-mortem appearances* are turgescence of the vessels of the brain, and redness of the membrane of the stomach.

Occasionally, in the practice of medicine, serious symptoms show themselves, without terminating fatally. There are dryness in the throat, and thirst; nausea; headache; salivation; giddiness, and dimness of sight, an appearance of sparks before the eyes, and a feeling of pressure on the eyeballs; with weakness of the limbs, and a weak and rapid pulse.

The symptoms arising from the gradual accumulation of the poison in the system are nausea, dryness of the mouth, loss of appetite, and vomiting, and intense thirst; giddiness, and throbbing of the temples; restlessness and sleeplessness; a hot and moist skin; great languor and depression, with, in most cases, a slow pulse. Diarrhœa, salivation, an increased flow of urine, delirium, spectral illusions, convulsions, and coma, are among the occasional symptoms.

Fatal Dose.—This has not been ascertained. No poison in common use is more uncertain in its operation; and in the treatment of inflammatory diseases, as well as in delirium tremens, it is often administered in doses which would be very unsafe in a state of health.

Pereira cites several cases of disease, both in children and adults, in which the tincture of digitalis was given in such doses as twenty drops three times a day to an infant, and from half an ounce to an ounce to an adult; but in the cases referred to by him, the natural operation of the poison was counteracted by disease accompanied by decided febrile action, or by intoxication attended by great excitement of the circulation.

The *treatment* will consist in the use of emetics, followed by

aperients, and by the free use of vegetable infusions containing tannin, such as infusion of nutgalls, or of oak-bark. These are given with a view of rendering the alkaloid *digitalia* inert. Green tea or strong coffee may also be given with advantage. Stimulants, such as ammonia, wine, and brandy, should also be administered, and the recumbent posture be strictly preserved. Friction to the spine, though less indicated than in poisoning by aconite, or when asphyxia is imminent, might be used with advantage; and, in desperate cases, artificial respiration, and galvanic shocks through the heart.

DIGITALIA (*digitaline*).—*Properties.*—When pure, this alkaloid is white and amorphous; when less pure, of a light yellow or brown colour. It belongs to the group of alkaloids which is changed in colour by cold sulphuric acid. The colour is a red-brown, which deepens when the acid is warmed, and still more when heated. Its colour is not changed by nitric acid.

When heated on porcelain, it darkens, melts slowly into a brown liquid, yields an abundant thick vapour, and swells into a bulky black ash. The vapour has the odour of the drug. When heated in the manner described at p. 386, it melts and sublimes at 310° Fahr. The sublimate is not characteristic.

Digitaline is sparingly soluble in cold or hot water, and has an intensely bitter taste. It does not form crystallizable salts with acids. It is soluble in alcohol, and in benzole.

Tests.—*a.* The effect of sulphuric acid as just described. *b.* The negative effect of nitric acid. *c.* On adding a solution of bichromate of potash to the recent solution in sulphuric acid, the liquid becomes first yellow then green. *d.* Hydrochloric acid turns it yellow, changing quickly to green. *e.* Its solution evaporated to dryness, and treated with sulphuric acid, yields a rose colour, which, on exposure to the vapour of bromine, is changed to *mauve.*

The interesting experiments of Drs. Fagge and Stevenson* have shown that this substance shares with the veratrum viride, squill, and one or two other poisons, the power of acting on the frog's heart in a characteristic manner, causing a peculiar form of irregularity in its beats, the stoppage of the ventricle in the white, contracted state, and the retention of the voluntary power when the heart stops, and for at least 15 to 20 minutes afterwards.

The quantity of the alkaloid in the leaves is less than one per cent.; and it is believed that a dose of $\frac{1}{16}$ grain would produce symptoms of poisoning in an adult.

* 'On the Application of Physiological Tests for certain Organic Poisons, and especially Digitaline:' Guy's Hospital Reports, 3rd Series, vol. xii. p. 37.

CHAPTER XV.

ASPHYXIANTS.

1. Carbonic acid, Carbonic oxide, and the products of combustion.
2. Sulphuretted hydrogen, and the gaseous contents of sewers and drains.
3. Carburetted hydrogen and coal gas.

The term "*asphyxiants*," placed at the head of this chapter, is used in the same sense as the words "narcotics," "deliriants," "inebriants," which distinguish other chapters. The gases are poisonous agents applied to the air-passages, and causing suffocation as a leading and conspicuous symptom, but, at the same time, giving rise to headache, giddiness, drowsiness, insensibility, and failure of muscular power, and, in exceptional cases, to spectral illusions, delirium, and maniacal violence, showing their direct action on the nervous system. In a state of concentration these gases may cause spasm of the glottis, and consequent death by suffocation; but, as usually inspired, they are largely diluted with atmospheric air, and not uncommonly with other purely irritant or otherwise deleterious gases.

I. CARBONIC ACID GAS.

Carbonic acid gas is generated in many different ways. It is the principal product of the combustion of fuel; is given out largely in the process of fermentation, and in the burning of lime; animals expire it, and plants exhale it freely at night; and it collects in mines, caves, coal-pits, graves, and wells. The gas produced in any of these ways may give rise to fatal accidents.

The question of accident, suicide, or homicide, is rarely raised in poisoning by this gas. The place in which a body is found, and the surrounding circumstances, are generally decisive as to the cause, which, in this country, is generally accidental. Suicides rarely resort to it, though the practice is very common in France; and it is not a likely instrument of murder, though some cases

related by Devergie seem to justify the suspicion that it has been so employed.

But though the cause of death in poisoning by carbonic acid will generally be inferred from the place and circumstances in which a body is found, suspicions of foul play have been ignorantly entertained; and the dangerous or fatal results have been attributed to mechanical suffocation (Reports of Ambrose Paré), or to some poison administered by the mouth (Christison).

Occasionally the true state of things is not suspected till several persons have suffered or perished; as when the woodwork of houses is carbonized by heated flues, or the products of combustion make their way from one apartment to another.

Properties.—Carbonic acid is a colourless gas, inodorous, but pungent to the nostrils. It is much heavier than atmospheric air, with which it mixes slowly. It is soluble in water, has the reaction and other properties of an acid, and combines with lime to form chalk.

Tests.—*a.* It produces a milkiness, followed by a white precipitate, in lime water. *b.* It does not support combustion; and when mixed with air, in the proportion of from ten or twelve to fifteen or twenty per cent., extinguishes flame. For a small flame as little as ten or twelve per cent. will suffice. *c.* Litmus paper moistened with bleaching liquid is first reddened, and then bleached by the gas as it exists in the air. A jet of carbonic acid is easily recognised by its pungent effect on the nostrils.

The property of combining with lime is turned to practical account in purifying the air of wells or pits. A vessel of lime, mixed up with water into a thin paste, is lowered into the stratum of gas. The same result may be obtained by a current of air or jet of steam.

Quantitative Analysis.—The quantity of carbonic acid in the air may be determined by the amount of absorption that takes place in a graduated jar containing liquor potassæ. The gas may be collected for analysis by emptying a full jar of water into the space containing it. The quantity of charcoal that has been burned in any case may be estimated at twenty or twenty-five times the weight of ash.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Carbonic acid gas, pure and unmixed, acts as an irritant, causing spasm of the glottis, and death by apnœa. In a state of dilution, whether pure or mixed with other products of combustion, it may be breathed for a considerable period; the symptoms varying in intensity with the quantity of the gas, and

their character being modified by the gases with which it may happen to be mixed. When mixed with the more active carbonic oxide, the narcotic symptoms are more urgent; the sulphurous acid gas given off during the combustion of coal irritates the organs of respiration; and other modifications may arise from the admixture of carburetted hydrogen, or of other hydrocarbons.

The ordinary symptoms of poisoning by carbonic acid are:—a sense of weight in the forehead and back of the head, and of tightness in the temples, violent headache, giddiness, ringing in the ears, dimness of sight, drowsiness, hurried respiration, and violent palpitation; nausea, and, in many cases, vomiting; followed by complete insensibility, stertorous breathing, slow pulse, pallor and lividity of the surface; and death from apoplexy, or from apnœa. Sometimes a deep sleep terminates in death. Occasionally the sensations seem, as in drowning and hanging, to be pleasurable; and in a few cases delirium has been an early symptom. Convulsions and tetanic spasms are of occasional occurrence.

An instructive case of recovery from poisoning by this gas, showing its effects on the nervous system, is related by Sir George Baker, on the authority of Heberden. A young man was shut up in the morning in a close room with burning charcoal till two small birds fell down dead in their cages, when he felt so ill as to be obliged to go into the open air. This he had no sooner done, than he fell down senseless. When he came to himself, he complained of giddiness, sickness, pain in his stomach and loins, and stupor, all which continued the whole day. Next day he felt better, but about 7 P.M. he was seized with violent pain of the stomach and loins, vomited, threw himself on the ground, fell into convulsions, and could hardly fetch his breath. Soon after he had a little recovered himself, he had a second fit of the same kind. About an hour afterwards he became delirious, and he was with difficulty kept in bed during the night. In the morning he came to himself, and had some quiet sleep; but the pain was not quite gone, and giddiness, with strange sights before the eyes, continued for some little time longer.*

Post-mortem Appearances.—The body is generally swollen, the skin marked more or less extensively with livid spots, the limbs often rigid, and the abdomen distended with air. The face is, in some cases, pale and composed, in others livid and bloated;

* An account of a singular disease which prevailed among some poor children, maintained by the parish of St. James, in Westminster, in the 'Medical Tracts,' by Sir George Baker, Bart., M.D., F.A.S., collected and republished by his son (1818), p. 616.

and the eyes are bright and prominent. Froth, or froth tinged with blood, is sometimes found about the mouth and nostrils; and the tongue is often protruded and grasped by the teeth. The animal heat is retained longer than usual, cadaverous rigidity is slow to show itself, and putrefaction is retarded. Internally the body presents the following appearances:—the large veins and right cavities of the heart gorged with black blood, and the lungs and lining membrane of the air-passages congested. The base of the tongue is injected, and ecchymosed patches are sometimes found in the alimentary canal. The abdominal viscera (and notably the kidneys) and the ascending cava are also greatly congested. The brain and its membranes are injected, and the veins and sinuses distended. Serum is found in the ventricles, and at the base; and there may be effusions of blood on the surface of the brain or into the ventricles.

Some of these appearances bear a close resemblance to those present in death by apnœa; but the turgescence of the brain is much more remarkable, and it has been proved experimentally that the gas does not act merely as an asphyxiating agent, but as a specific narcotic poison.*

Treatment.—This consists in prompt removal to a pure air, the use of cold affusion as a shock, and, when the face is bloated and livid, of blood-letting. Friction and warmth to the surface are indicated, as in cases of apnœa. Artificial respiration, galvanism, and the inhalation of oxygen gas may be resorted to in extreme cases.

* As the value of some of the post-mortem appearances was a subject of lively controversy in the case of James Trickey, given in the text, the following particulars are subjoined from a paper by Dr. Golding Bird: 'Guy's Hospital Reports,' vol. viii. p. 75.

The *expression of countenance* was noted in 12 cases: it was pale and calm in 5; bloated in 7. *Vomiting* had occurred in three cases, and was absent in 5 in which the symptom was noticed. There was *froth at the mouth* in 6 cases; it was absent in 4. There was *froth and serum* at the nostrils in 4, and they were lined with black mucus in 2. The *eyes* were injected in 2; dilated, prominent, and shining in 3; closed and dull in 3. The *limbs* were rigid in 5; flexible in 2. The *tongue* was protruded and grasped by the teeth in 6; drawn in and concealed in 2. There were livid patches on the skin in 10 cases; they were absent in 2. The *abdomen* was distended in 9; not distended in 4. The *membranes of the brain* were injected with blood in 8, and described as congested in 4; there was *serous effusion* beneath the arachnoid in 3, no effusion on the brain in 6; and *serous effusions* in 3. The *vessels and sinuses* were turgid in all the cases in which those parts are mentioned. The substance of the brain was injected in 8. Blood was effused on the surface in 1. Serum in the *ventricles of the brain* in 6; absent in 3. Blood was effused into them in one case; the brain was in its natural condition in two cases. The blood throughout the body was not always of the same colour.

Devergie lays great stress on the rosy or livid discoloration of the skin, and on the persistence of animal heat and rigidity, and the slow march of putrefaction, in these cases. ('Annales d'Hygiène,' vol. xvii. p. 225.)

Preventive Measures.—The prevention of accidental poisoning by carbonic acid must rest in a great degree on the possession on the part of the public of correct information respecting combustion and its products, and of the situations in which accumulations of the gas are most likely to take place. The fact that stoves heated by charcoal in the open air of rooms, and giving out carbonic acid, are used by persons of education, shows how little scientific knowledge they may possess. But even intelligent and educated persons do not always understand that it is unsafe to breathe air in which a candle continues to burn. It should, on the contrary, be understood that a candle may burn in an atmosphere which will speedily prove fatal to life; while, on the other hand, a man may for a short time breathe with impunity air in which candles are extinguished. Thus, Mr. Coathupe cites the case of a man who descended into an abandoned coal-pit, in which lighted candles were repeatedly extinguished, remained in it for several minutes, and succeeded in recovering the body of a child, who had fallen from a part of the old machinery. Again, in a case mentioned by M. Marye, and quoted by Devergie, a candle was extinguished in an atmosphere that produced only a slight sensation of uneasiness in a gentleman who made an abortive attempt at suicide. In another and successful attempt, a candle was found burning on the table, whilst he was lying dead on the floor. In the former instance, the candle was probably below the level of the body, in the latter, above it.*

Several interesting and practically important questions connected with poisoning by carbonic acid require examination. Some of them are set forth in the following case, which, at the time of its occurrence, excited a lively interest, and gave rise to much discussion.

James Trickey, aged 66, watchman and steeple-keeper of St. Michael's Church, Cornhill, on the night of Nov. 17, 1838, was placed in charge of a stove heated by charcoal (one of Harper and Joyce's patent apparatus). He entered the church at eleven o'clock at night, and next morning was found dead, lying on his face, with his feet about a yard from the stove, and his head lower than the rest of his body. Much vomited food was found on the floor near his mouth. The church was so full of vapour that the respiration of the persons who first entered in the morning was considerably affected. The principal post-mortem appearances were as follows:—The countenance calm and composed, and the eyes lustrous. The vessels of the brain gorged

* 'Annales d'Hygiène,' vol. xxiii. p. 190.

with fluid blood; considerable serous effusion between the arachnoid and pia mater, and at the base of the brain; numerous bloody points in its substance. The lungs almost black, the vessels turgid with blood, the trachea containing a frothy mucus, and the lining membrane injected; the blood in the large veins dark, but fluid; the stomach nearly full of undigested food. Every other part of the body healthy.

At the inquest there was great difference of opinion among the medical witnesses as to the cause of death. They all agreed that he had died of apoplexy; but some thought the death sufficiently explained by his advanced age and apoplectic make, and the full meal taken before he commenced his watch in the church. Others, on the contrary, though they also attributed the death to apoplexy, traced the apoplexy itself to the inhalation of carbonic acid.

The question to be decided, therefore, ultimately took this shape: Was there enough carbonic acid in the church to account for death; and if the quantity diffused through the church was not sufficient to account for the fatal event, might not the part in which he lay (for he was on the floor close to the stove) contain a sufficient quantity of the gas to prove fatal? As similar cases, involving like questions, may again occur, it may be well to say a few words on each of these points.

1. What is the smallest quantity of carbonic acid diffused through the air that may prove fatal?

2. Is the carbonic acid produced in the burning of fuel in rooms or buildings equally diffused, or does it accumulate in one part of the apartment more than another?

1. In estimating the quantity of carbonic acid required to destroy life, it should be borne in mind that when the gas is the product of respiration or combustion it is formed at the expense of the oxygen of the air; so that the air is rendered less fit for the support of life by the withdrawal of a vital element, as well as by the addition of a poison. The different susceptibility of persons of the two sexes and different ages should also be considered (see p. 255). Some light is thrown on this question by the experiments of Allen and Pepys, which showed that air once inspired becomes charged with from 8 to $8\frac{1}{2}$ per cent. of carbonic acid, and that, however often it may be breathed, it never acquires more than 10 per cent. But as fatal consequences have more than once ensued from simple overcrowding, when the pollution of the air, in all probability, fell far short of this limit, we may safely assume that a quantity of carbonic acid much less considerable would destroy life. Devergie thinks that five per

cent. is sufficient, but Mr. Coathupe* states that he suffered most severely from inhaling an atmosphere containing, at the outside, according to his own calculation, 2 per cent.

In the case of St. Michael's Church, it appears that the contents of the building were 110,000 cubic feet, and the quantity of carbonic acid which might have arisen from the charcoal employed was 1500 cubic feet; so that little more than $1\frac{1}{3}$ per cent. of the gas could have been diffused through the building, a quantity probably much smaller than that contained in crowded and ill-ventilated rooms, especially when lighted by gas, and probably too small to destroy life, though breathed by a sleeping man for several hours in succession. The death of James Trickey could not therefore be attributed to the inhalation of carbonic acid on the supposition that the gas is uniformly diffused through the air of the building. But if, as some believe, and as the experiments of Devergie seem to prove,† the gas is unequally distributed, and, when the temperature of the apartment has become the same in every part, subsides to the floor, the death of James Trickey, who lay on the floor of the church within three feet of the stove, was probably due to the poisonous gas which he inhaled. But in order to explain the death of James Trickey by carbonic acid, it is not necessary to assume this subsidence of the gas to the lower part of the building; for except in those cases in which this heated gas given off from the burning fuel rises in a column to escape by a vent in the ceiling directly above it, it will doubtless be diffused in larger quantity through the air near the stove, whether above, around, or beneath it; and if the air of the apartment, instead of being assumed to be still, is subject to draft, the gas would be carried in the direction of the draft, so as to increase the danger of a person exposed to it. If the draft, however, be strong, it will clear the air of the carbonic acid which it contains, and free those who may happen to be in the current from all danger. This circumstance is illustrated by a case reported by Dr. Golding Bird, which also seems to place beyond all reasonable doubt the greater immediate accumulation of the gas in the proximity of the stove, than in the parts remote from it.‡

That such diffusion of the gas does happen may be proved by placing lime water in watch-glasses, in different positions, near

* 'Lancet,' vol. xxxi. p. 201.

† These experiments derive some confirmation from a case quoted by Devergie from a work by M. Marye, for which the reader is referred to the first edition of this work.

‡ 'Guy's Hospital Reports,' vol. viii. p. 84.

the source of supply. It soon becomes coated with a film, of about equal thickness, in whatever position it is placed. This equal diffusion of the gas is the more probable explanation of the death of James Trickey, assuming it to have been due to carbonic acid.

The following is a short summary of the more obvious causes of an unequal distribution of carbonic gas, or of other products of combustion.

1. Carbonic acid may be generated (as in beer-vats) in an inclosed space, and form a stratum above the source of supply, at the same time that it mixes very slowly with the atmospheric air above and around it. 2. Carbonic acid may enter an inclosed space (such as a well, cavern, or grotto) from openings in the floor. In this case, too, if the air of the upper part of the space be renewed by strong currents of air, or by the occasional opening of a door, the lower stratum may be poisonous, while the upper strata are comparatively pure. 3. Carbonic acid may be generated in an apartment by combustion, and rise as a compact column of heated air to a vent in the ceiling; or it may be drawn towards an open chimney; or, again, it may be forced into a particular direction by currents of air. 4. In an apartment without chimney, or other vent, and with no currents or drafts of air, or only very feeble ones, the gas will be diffused abundantly, though unequally, around the source of supply.

Other Products of Combustion.—Carbonic acid, though the chief, is not the only product of the combustion of charcoal or coal. In the case of burning charcoal, the gases given off vary according to the rapidity with which the fuel is consumed. According to Orfila, the gas from dimly-burning charcoal consists of 14 parts of carbonic acid and 14 parts of carburetted hydrogen, mixed with 52 parts of nitrogen and 20 of atmospheric air; while the products of vivid combustion are 12 parts of carbonic acid, 39 of nitrogen, and 49 of atmospheric air. Well-burned charcoal, therefore, yields little or no carburetted hydrogen; but it gives off, in variable quantity, a most active narcotic poison, not mentioned in this statement of M. Orfila—viz., carbonic oxide.

Where, then, combustion goes on slowly, a much larger quantity of air is deprived of its oxygen than when combustion is vivid.

The gases given off in the smothered combustion of coal are of a much more compound nature than those produced from charcoal. In addition to carbonic acid, we may expect to find sulphurous acid gas, and the sulphuretted and carburetted hydrogen gases. These also are highly injurious to life.

II. SULPHURETTED HYDROGEN (*Hydrosulphuric Acid*).

This gas ranks next in importance to carbonic acid. It is scarcely less generally diffused, but being of a most offensive odour gives warning of its presence. It is an extremely active poison, for according to Thénard atmospheric air, which contains $\frac{1}{1500}$th of its volume will destroy a bird; when it contains $\frac{1}{800}$th of its volume it will kill a dog; and $\frac{1}{250}$th proves fatal to a horse. Injected into the blood, it speedily destroys life; and it also proves fatal when introduced into any of the cavities of the body, or even when applied to the unbroken skin.

Properties.—This gas is characterized by a peculiarly offensive odour—that of rotten eggs. It is also remarkable for the variety of its reactions with the metallic bases. It combines with ammonia to form the sulphide of ammonium, which has a similar offensive odour added to the pungency of hartshorn, and similar chemical reactions. The presence of ammonia is indicated by the fumes given out when a rod dipped in hydrochloric acid is held in the gas.

Tests.—The usual test for this gas is acetate of lead, which throws down a brown or black precipitate, according to the quantity of the gas. Filtering paper moistened with a solution of the salt of lead is a very delicate test.

Symptoms.—When the gas is breathed in a moderately diluted state, it causes giddiness, a sensation of tightness across the temples, and of oppression at the pit of the stomach, nausea, sudden weakness, and loss of sense and motion. Delirium, tetanus, and convulsions, a cold skin, an irregular and very frequent pulse, and laborious respiration, are occasionally present.

Post-mortem Appearances.—The body has a highly offensive odour, and undergoes very rapid decomposition. The muscles are dark, and insensible to the stimulus of galvanism. The large vessels and all the internal viscera are distended with black liquid blood.

Treatment.—This consists in prompt removal to a pure air, the use of stimulants, and the respiration of *chlorine* gas as given off from bleaching powder moistened with a dilute acid, or from any of the bleaching liquids. As chlorine is a powerful irritant it should not be administered in too concentrated a form.

Sulphuretted hydrogen rarely exists in a separate state as a poison; but is most commonly met with in union with other gases in privies, cesspools, and common sewers.

Feculent matter in a state of putrefaction gives rise to three principal gases—sulphuretted hydrogen, sulphide of ammonium,

and nitrogen. The first two are exceedingly deleterious, the latter possesses negative properties. They exist separately or combined in the soil of privies. Sometimes it happens that no disagreeable odour is given out; neither the nauseous odour of the sulphuretted hydrogen, nor the irritating and pungent odour of the sulphide of ammonium, but still the air is contaminated. In these cases the gases consist of carbonic acid and nitrogen, with a very small proportion of oxygen.

The symptoms and post-mortem appearances produced by the gases taken collectively will not differ much from those due to the inhalation of sulphuretted hydrogen alone. The rapidity with which the symptoms take place will be proportioned to the degree of concentration of the gas. The most remarkable symptoms produced in those who have been suddenly and strongly affected and subsequently recovered, are, a feeling of violent pressure at the epigastrium, and round the head. Men employed in emptying the common sewers in Paris are frequently affected in this way.

For the purification of the air from these gases, as well as for the recovery of persons asphyxiated by them, chlorine is the proper agent.

The gases arising from the stagnant water of sewers are similar to those given off by privies and cesspools; but they are partly held in solution by the water. In sewers with a good fall and liberal supply of water no gases are given off; but there is a peculiar animal odour due to their feculent contents. This odour does not appear to exercise any injurious effect on the health of men who work in sewers.

III. CARBURETTED HYDROGEN.

The chief constituent of coal gas is the combination of carbon and hydrogen known as light carburetted hydrogen, sub-carburetted hydrogen, marsh gas, or fire damp. In coal gas the light carburetted hydrogen is mixed with olefiant gas, and unless of unusual purity contains several other gases, such as ammonia, sulphuretted hydrogen, carbonic acid, and carbonic oxide, with free hydrogen and nitrogen.

Properties.—These mixed gases have a peculiarly offensive odour. They burn with a yellowish-white flame, yielding chiefly water and carbonic acid, and forming, with certain proportions of atmospheric air, a dangerous explosive mixture.

Coal gas is not so active a poison as carbonic acid or sulphuretted hydrogen; but when mixed with an equal bulk of atmospheric air it cannot be breathed without producing very serious

effects upon the system. If greatly diluted no bad effects follow, as is proved by the fact that men who work in coal mines are rarely incommoded by it.

Symptoms.—Very few cases of poisoning by coal gas, or its principal constituents, are recorded. In a case described by Devergie, there were foaming at the mouth, vomiting, violent convulsions, tetanic spasms, stertorous respiration, bloated face, and dilated pupil.

Post-mortem Appearances.—From two cases reported by Mr. Teale,* it seems that the principal morbid appearances are the following:—Pallor of the integuments, and of the internal tissues generally, with the exception of some portions of the mucous membrane; florid discoloration of the neck and back; light florid colour of the muscles; absence of all indications of venous congestion; fluidity of the blood, which is of a florid colour; infiltration of the lungs; injection and ecchymosis of the small intestines, and of the air-passages. Rigidity rapidly supervenes.

Treatment.—This consists in prompt removal into the air, and the cold affusion, followed by diffusible and other stimulants.

* 'Guy's Hospital Reports,' No. viii. p. 106.

CHAPTER XVI.

VEGETABLE IRRITANTS.

1. Purgatives.—Aloes, colocynth, gamboge, jalap, scammony, seeds of the castor-oil plant, croton oil, elaterium: the hellebores and colchicum.
2. Abortives.—Savin, and ergot of rye.
3. Irritants, with nervous symptoms.—Cicuta virosa, phellandrium aquaticum, æthusa cynapium, yew, and laburnum.
4. Simple irritants.—Arum, mezereon, ranunculus, bryony (white and black), &c. &c.
5. Diseased and decayed vegetable matters.

I. PURGATIVES.

This group comprises both the more active purgatives now used in medicine, or by the vendors of aperient pills, and the now disused hellebore, which was in earlier times so largely given for the cure of melancholic disorders. Of the purgatives now in use it may suffice to state that when given in large doses, or to old and infirm persons, they may act as poisons. All those enumerated at the head of the chapter, given alone or in combination, have proved fatal. Their poisonous property resides chiefly in their oily or resinous constituents. Aloes and jalap yield active principles—*aloine* and *jalapine*, the white hellebore (veratrum album), the alkaloid *veratria*, and colchicum, *colchicine*.

The *symptoms* produced by this class of poisons are those of irritation of the alimentary canal—vomiting and purging, with pain in the abdomen, cramps, tenesmus, and strangury. The patient falls into a state of collapse, attended occasionally with drowsiness and slight nervous symptoms.

The *post-mortem appearances* are those of inflammation of the alimentary canal in various degrees and stages—redness, ulceration, softening, and effusion of dark blood into the submucous tissue.

The proper *treatment* consists in the free use of diluents, with liberal doses of opium to relieve pain, and stimulants to counteract the collapse.

Some of the medicines belonging to this group are deserving of more special mention.

ALOES.—This drug owes its importance to the large number of preparations of which it forms a leading constituent. The British Pharmacopœia contains no less than ten preparations into which it enters, and in most of the quack aperient pills it is a leading ingredient. When mixed with powdered canella, in the proportion of four parts to one, it constitutes the well-known aloetic powder, hiera-picra, or holy bitter. This popular remedy, as well as the quack pills which the public are encouraged to take in any quantity, have proved fatal. Aloes yields an active principle (*aloine*), which is distinguished by giving with cold sulphuric acid a yellow colour, greatly heightened when the solution is warmed, and changing to green when heated. It is also turned orange by nitric acid.

JALAP.—This also is a drastic purgative, which yields an active principle (*jalapine*) characterized by the yellow tint it gives to cold sulphuric acid, heightened to deep orange when warmed, and to a red-brown when heated. It is turned yellow by nitric acid.

Fig. 166.

CASTOR-OIL SEEDS.—Of the seeds of the ricinus communis, or castor-oil plant (Fig. 166) it will suffice to state that they act on the stomach and intestines with a violence quite disproportioned to the action of the oil which they would yield on compression. Two or three seeds act as a drastic purgative; three seeds have destroyed the life of an adult male in forty-six hours, and twenty seeds that of a young lady in five days, with symptoms of violent irritation of the stomach and bowels, and an appearance as of "one affected with malignant cholera."*

CROTON OIL.—The expressed oil of the croton tiglium (fig. 167) is a poison of some importance. It has more than once destroyed life with symptoms of acute irritant poisoning, and collapse resembling that of the worst forms of English and Asiatic cholera. The following abstract of a case

* Taylor's 'Principles and Practice of Medical Jurisprudence,' p. 266.

Fig. 167.

described by Dr. Greenhow, affords a good example of this form of poisoning :—

An old lady took by mistake an embrocation containing 30 minims of the oil. When seen two hours afterwards, she had all the appearance of a person in the cold stage of cholera. There had been profuse purging of matters exactly resembling the rice-water stools of cholera patients, and severe cramps. The surface was cold, the features shrunken, the skin even more blue than is usual in cases of true cholera, the pulse thready and almost imperceptible, and the respiration gasping. She was very restless; but her intellects were unimpaired, and she died ten hours after taking the poison.*

Elaterium.—The fruit of the wild or squirting cucumber (fig. 168) yields a juice of such active properties, that the dried sediment, or extract, of the British Pharmacopœia, is prescribed in a dose of from $\frac{1}{16}$ to $\frac{1}{2}$ grain, while *elaterine*, its active principle, is effective in the small dose of $\frac{1}{96}$ grain. It constitutes about a fourth part of the extract. With cold sulphuric acid, it yields a red-brown solution, deepened in tint by warming, and still more when heated. Nitric acid does not change its colour. Christison quotes from a French authority, the singular case of a medical gentleman in Paris, severely affected with pain and tightness of the head, colic pains, purging, bilious vomiting, and fever, through carrying a specimen of the plant in his hat for twelve hours.

Fig. 168.

The Hellebores.—The *helleborus orientalis*, or true hellebore, with its black root, or *melampodium*, was

* 'Medical Times and Gazette,' August, 1866, p. 142.

largely used by the ancients as an efficient purgative in disorders, bodily and mental, supposed to depend upon black bile. The helleborus niger, viridis, and fœtidus, as well as the white hellebore, or veratrum album, have similar properties, and have a certain importance as poisons. The H. viridis furnishes a tincture to the British Pharmacopœia, of which the dose is from 5 to 20 minims.

Fig. 169.

The *helleborus niger*, or black hellebore, is named, like the oriental species, from the dark or black colour of its root; and hence, also, the name "Melampodium" of the old Pharmacopœias. It grows in shady woods, and flowers in January, as the "Christmas rose." The leaves and root are poisonous; and the powdered root is a brisk purgative, and, as well as the leaves, a favourite but dangerous worm-medicine with the vulgar.

The *symptoms*, *post-mortem appearances*, and *treatment*, are those proper to irritant poisons generally (p. 358), with violent action on the bowels, and marked symptoms of collapse. A decoction of the root has destroyed life, after producing vomiting, delirium, and convulsions, in less than two hours.

The *helleborus fœtidus*, stinking hellebore, bearsfoot, or fetterwort, is also a very virulent poison, having a similar action to the preceding, but more powerful. It is known in Westmoreland, where it grows abundantly, as *felon-grass*. It has long been in use as an efficient vermifuge.

Fig. 170.

The *helleborus viridis*, veratrum viride, or green hellebore (fig. 171), possesses the same poisonous properties as the foregoing, and derives some additional importance from furnishing to the British Pharmacopœia a tincture, of which the dose is from 5 to 20 minims. It appears also to be a poison in common use in North America, where it is known as "Indian poke." From several cases cited by Wormley,* it appears that the poison occasions pain in the stomach, nausea, retching and vomiting, diarrhœa, with discharges of blood and tenesmus, with a weak and rapid pulse, and extreme prostration. In a gentleman who took a teaspoonful of the fluid extract there was vomiting for some hours, and total loss of speech and of locomotion for some

* 'Micro-Chemistry of Poisons,' p. 646.

time. An ointment containing the veratrum viride, when applied to an ulcer on the leg, produced vomiting.

The *veratrum album*, or white hellebore, is not an indigenous plant, but grows abundantly in the mountain districts of the Continent. (Fig. 172.) Every part of this plant is poisonous;

Fig. 171.

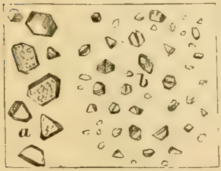
Fig. 172.

but the powdered root, or an infusion from it, has been most commonly taken as a poison. The powder has nearly the colour of powdered jalap, has an acrid, bitter taste, and strongly irritates the nostrils. Hence it is sometimes used, mixed with starch, as an errhine; but its principal use is to destroy vermin on the skin or hair.

The *symptoms, post-mortem appearances*, and *treatment*, are those proper to irritant poisoning (p. 358), with a tendency to death by collapse. The pupils are dilated. As little as twenty grains of the powder has killed in three hours. It owes its poisonous properties to the alkaloid *veratria*.

VERATRIA (*Veratrine*).—This alkaloid is contained in the Cebadilla (the fruit of the asagræa officinalis) as well as in the root stock of the Veratrum album, and V. viride. It is prepared from the cebadilla (British Pharm. p. 365), and is the active ingredient in the unguentum veratriæ (8 grains to 1 ounce). The pure alkaloid is a white amorphous powder, without odour, but violently irritating to the nostrils, and of an intensely bitter and highly acrid taste. It is insoluble in water; but more or less readily dissolved by alcohol, ether, chloroform, benzole, and fusel oil. It has a slightly alkaline reaction, and forms soluble salts with the acids. Strong sulphuric acid first turns it yellow, then a rich crimson, the change taking place instantaneously when the acid is gently heated. When heated on a porcelain slab it darkens, melts readily into a yellow liquid, blackens, and spreads into an abundant carbonaceous layer. The vapour has a disagreeable pungent odour; and, when received on a clean disk, deposits detached crystalloids, or crystals described as rhomboidal, but among which several octahedra can be discovered. These crystals, in two degrees of enlargement, are shown in fig. 173. When heated on platinum-foil, the alkaloid is entirely consumed.

Fig. 173.



Experiments on Animals.—Two grains of veratria in solution given to a cat, began to act immediately, causing frothing at the mouth and collapse, and death in less than a minute. Three grains given to a young dog, caused immediate and repeated vomiting, involuntary discharge of urine, great prostration, and death in two hours.

Symptoms in Man.—Copious vomiting, extreme prostration, cold damp skin, failing pulse, and all the symptoms of collapse.

Post-mortem Appearances.—Marks of acute inflammation in the alimentary canal.

Treatment.—The prompt use of the stomach-pump, or, in the absence of vomiting, emetics of sulphate of zinc. Vegetable infusions containing tannin, as an antidote, or finely-divided charcoal. The collapse to be met by diffusible stimulants and by opium, which seems to have been useful in some cases.

Fatal Dose.—A fraction of a grain. A sixteenth of a grain has produced a state of dangerous collapse. (Taylor.)

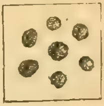
Fatal Period.—It may be inferred from experiments on animals, that death would happen speedily.

COLCHICUM (*Colchicum autumnale, Meadow saffron*).—This plant grows in moist meadows in every part of Europe. It flowers in autumn, and throws out its leaves in spring; and it has a fibrous root attached to the under side of an underground stem or corm. The fruit, which ripens about mid-summer, contains several round seeds. The annexed figure shows the plant (A), the flower (B), and the capsule (C). The corm and seeds are used in making several preparations of the British Pharmacopœia—the fresh corm for the extract, and acetic extract, the dried corm for the wine, and the seeds for the tincture. The corm has been taken by mistake for onions; and the seeds, wine, and tincture have also been taken in poisonous doses.

Fig. 174.

The *symptoms* are sometimes slow in showing themselves, even when large doses of the wine or tincture are taken; but in other cases they begin almost immediately, and death may take place in as short a time as seven hours. The symptoms are those of irritation of the alimentary canal, with collapse. Nervous symptoms are rare. The *post-mortem appearances* and *treatment* are those proper to poisoning by the irritants (p. 358). Stimulants must be freely used to counteract the extreme debility.

Fig. 175.



The seeds of colchicum are globules of a reddish-brown colour, very hard, and shrivelled on the surface, of the size shown in the figure, and weighing eight, ten, or twelve to the grain.

Colchicum owes its poisonous properties to an alkaloid, allied to veratria, and named *colchicina*, of which less than half a grain has proved fatal to an adult.

II. ABORTIVES.

SAVIN (*Juniperus sabina*).—A small indigenous bushy shrub, yielding a round purple fruit about the size of a currant (fig. 176). It has a peculiar strong odour, and an acrid taste; and owes its irritant properties chiefly to an essential oil readily ob-

Fig. 176.

tained from the fresh tops of the plant by distillation with water. This oil, and an ointment from the freshly-bruised plant, are in the British Pharmacopœia. The dose of the oil is from one to five minims.

The leaves, in powder or infusion, and the oil, are often given with a view to procure abortion; but it has more frequently proved fatal to the mother than effectual in destroying the child. Savin is also in occasional use as a vermifuge.

Symptoms.—Those of irritation of the alimentary canal. Severe pain in the belly and vomiting, and sometimes strangury, but diarrhœa rare. Salivation and insensibility are occasional symptoms.

Post-mortem Appearances.—Those of acute inflammation of the alimentary canal. The green powder is often found among its contents. On drying and rubbing this powder, it emits the peculiar odour of the plant, and the hard thick parts of the twigs exhibit under the microscope the ordinary characteristics of coniferous wood. Watery solutions of savin strike a deep green with permuriate of iron.

Fig. 177.

Treatment.—That proper to the whole class of irritants.

Ergot of Rye (*Spurred rye, Secale cornutum*).—This is the product of a disease attacking the grain of several plants, such as wheat, barley, oats, and rye, in wet seasons, and in ill-drained soils. The ear of the plant is occupied wholly, or in part, by the diseased grains, each of which is of a deep purple colour, elongated, slightly curved, and projecting, so as to bear some resemblance to a cock's spur. These diseased grains, collected, dried, and powdered, form the ergot of the shops, used by the accoucheur to promote contraction of the uterus, and sometimes

criminally administered to procure abortion. Fig. 177 shows side by side the healthy (1) and diseased plant (2), an enlarged spikelet (*d*), a section showing the sporidia (*k*), the sporules (*l*), and two entire and full grown samples of the ergot (*g* and *h*).

Properties.—The ergot, when entire, varies in length from a quarter of an inch to two inches, and in thickness from a sixth to a third of an inch. Its surface is black, with lighter dotted streaks, and its substance reddish-grey. It is lighter than water, has a disagreeable odour, and somewhat acrid taste.

Tests.—*a.* Liq. potassæ gives it a lake-red tint, and developes the characteristic odour. *b.* The filtered alkaline liquid has the same colour, and lets fall the same coloured precipitate, on the addition of nitric acid, or a solution of alum in excess.

Experiments on Animals.—The symptoms produced in animals by large single doses, or by smaller doses frequently repeated, are partly those of intestinal irritation, partly those indicative of affection of the nervous centres. To the first belong diarrhœa, to the last giddiness, dilated pupil, drowsiness, and paralysis. Suppurating tumours, and gangrene of the extremities, are also among the symptoms.

In the human subject a single full dose gives rise to irritation of the stomach and bowels, giddiness, headache, and flushing of the face, with great lassitude and weariness.

When the spurred rye, or other grain similarly diseased, is mixed with flour and made into bread, it gives rise to an epidemic malady, which assumes the form either of *convulsive* or of *gangrenous ergotism.* In the first form nervous symptoms, such as giddiness, weakness of the limbs, mental incapacity, coma, and convulsions predominate; in the latter, dry gangrene of the extremities.

III. IRRITANTS WITH NERVOUS SYMPTOMS.

This group of poisons may be considered as the unclassed remnant of the large division of poisons formerly known as the *narcotico-irritants.* Their very decided action on the stomach and bowels, separates them from the group of convulsives of which strychnia is the type, and from that of depressants, of which conium is the best representative. Cicuta virosa is allied to the first; laburnum, perhaps, to the second.

CICUTA VIROSA (*Water Hemlock, Cowbane*).

This is a perennial, indigenous, umbelliferous plant, growing in wet ditches and on the banks of streams, flowering in July and August. It attains three or four feet in height, has a

stunted stem, and large dark-green tripartite leaves. The leaflets are grouped in twos or threes, narrowly spear-shaped and serrated; and the leaf-stalks are of a reddish colour where attached to the stem. The flowers are borne on many-rayed umbels. The root stalk, which has been repeatedly mistaken for parsneps, is hollow and filled with large cells. Fig. 178 shows a cutting of the plant, with a flower, and calyx.

Fig. 178.

The cicuta virosa has been described as "by far the most active of the poisonous plants of Great Britain;" and reasons have been assigned for the belief that it supplied the "celebrated Athenian poison."*

In *animals* the root gives rise to tetanus. In *man* well-marked tetanic spasms are also among the prominent symptoms, together with dilated pupil, insensibility, coma, nausea, vomiting, and diarrhœa. Death may take place within an hour of the swallowing of the poison.

Wepfer gives the cases of two boys and six girls who ate more or less largely of the roots. The boys who took a large quantity

* Stephenson and Churchill's 'Medical Botany,' vol. ii. pl. 89.

were soon seized with acute pain in the stomach, loss of speech, insensibility, and terrible convulsions. The mouth was so closely shut that it could not be opened, blood flowed from the ears, and the eyes were horribly distorted. Death took place in half an hour. The girls suffered from epilepsy.

The cases of three German soldiers related by Boerhaave show that the *post-mortem appearances* were well marked. They, too, died in less than half an hour; and the stomach of one was found perforated, the stomachs of the others corroded.

PHELLANDRIUM AQUATICUM (*Fine-leaved Water Hemlock*).

This, too, is an indigenous umbelliferous plant, growing in similar situations with the foregoing, and of which the tapering root eaten by mistake for parsneps has produced poisonous

Fig. 179.

effects. The plant grows to about three feet in height, and is furnished with small finely-divided dark-green leaves. (Fig. 179.)

ÆTHUSA CYNAPIUM (*Fool's Parsley*).

The leaves of this plant, as its name implies, have been eaten by mistake for parsley. The roots also have been eaten by mistake for young turnips. It is an annual umbelliferous plant, growing in gardens and fields, and may be recognised by the

Fig. 180.

secondary involucres appended to the flower-stalks, which are composed of three long and narrow drooping leaflets (bracts). When rubbed, the leaves have a nauseous odour. When given to *animals* it occasions convulsions and stupor. The symptoms in *man* are heat in the mouth and throat, nausea and vomiting; with headache, giddiness, stupor, dilated pupil, convulsions, and locked jaw.

YEW (*Taxus baccata*).—The leaves and berries of the yew (fig. 181) are poisonous. The leaves have proved fatal to animals, and the leaves and berries to man. The leaves, in substance or in infusion, are sometimes given as a vermifuge or abortive.

Symptoms.—Those of irritant poisoning, with the addition of nervous symptoms, such as insensibility and convulsions. Death may take place quickly from collapse; or, at a later period, from inflammation of the alimentary canal. The leaves have killed an adult in fourteen hours, and the berries a girl five years old in four hours.

Fig. 181.

Post-mortem Appearances.—Those of irritation of the alimentary canal. The leaves or berries are generally found in the stomach, and are readily identified. The leaves are lancet-shaped; and the berries, the size of a pea, consist of a hard, brown egg-shaped seed, enclosed in a light red covering, and surrounded by a colourless viscid juice, which has an acid reaction and a nauseous taste.

LABURNUM (*Cytisus laburnum*).—Every part of this common plant appears to be poisonous, and cases are on record of poisoning by the seeds, flowers, and bark. All parts of the plant have an extremely nauseous and disagreeable odour and taste. It owes its poisonous properties to an alkaloid known as *cystisin*. From Christison's experiments with the dried bark, it follows that the laburnum is an extremely active poison, producing in a few minutes violent tetanic convulsions, and speedy death. In man, too, the symptoms are very well marked, consisting of violent irritation of the alimentary canal, with great exhaustion, drowsiness, and rigidity of the limbs, convulsions, dilated pupil, and frequent pulse.

Two cases of poisoning by the bark eaten by a girl of ten, and a boy of eight, in mistake for liquorice, reported by Mr. Sedgwick, of Boroughbridge, show that the laburnum does not always produce the symptoms just enumerated. They were such in these cases as to qualify the plant for a place among depressants rather than convulsives. The symptoms of depression preceded the administration of tartar emetic as a vomit. In the boy the symptoms set in an hour and a quarter after eating a piece of the root the size of a walnut; in the girl, who had eaten about three times as much, they began after about the same interval. In

both the first symptoms were vomiting, giddiness, extreme weakness, pallor and coldness of the skin, and a feeble fluttering pulse. The pupil was dilated. Drowsiness showed itself later; but there was at no time any marked pain of the abdomen, nor was there any purging. Besides the drowsiness there were no head symptoms.*

IV. SIMPLE IRRITANTS.

ARUM (*Arum maculatum, lords and ladies, cuckoo-pint*).—The green spotted arrow-shaped leaves (1) of this plant appear early in spring in hedge-rows, woods, and shaded spots; the green spathe (2), with its purple column (3) enclosed, in May; and a cluster of bright-red berries (4) alone, towards the end of summer. The root is tuberous and somewhat heart-shaped, and

Fig. 182.

like all other parts of the plant, is highly acrid and irritating. The juice applied to the tongue causes acute darting pain, as if it were pierced with sharp needles; and in three children who ate of the leaves of the plant, the tongues were so swollen as to render swallowing difficult. Two of the children died in twelve and sixteen days respectively: the third recovered. The poisonous properties of the plant are wholly dissipated by heat: and the roots, first steeped in water, and then baked and powdered, constitute the "*Portland sago.*" The *symptoms, post-*

* 'Medical Times and Gazette,' Jan. 3, 1857.

mortem appearances, and *treatment* are those proper to irritant poisoning.

Fig. 183.

MEZEREON (*Daphne mezereum*).—This is a cultivated garden shrub yielding bright red berries, apt to attract the notice of children, and to be mistaken for currants (fig. 183). They contain a single ovate seed, composed of two plano-convex cotyledons enclosed within the coat. The plant has highly irritating properties. Five or six of the berries are sufficient to produce serious effects. The bark is an ingredient in the compound decoction of sarsaparilla of the British Pharmacopœia, and is the basis of the ethereal extract of mezereon. The *symptoms*, *post-mortem appearances*, and *treatment*, are those of irritant poisoning.

Fig. 184.

RANUNCULUS (*Crowfoot, buttercup*).—There are no less than fifteen species of ranunculus, or crowfoot, natives of these islands, and common in our meadows and pastures, and most of them have more or less irritating properties. Those which are esteemed most poisonous are the ranunculus flammula, bulbosus, and sceleratus; the R. acris and arvensis being less deleterious. Fig. 184 shows a plant of the ranunculus acris. Every part of the fresh plant is pervaded by an acrid principle, which, like that of arum maculatum, is volatile, and dissipated by heat, or when the plants are dried. Water distilled from the fresh plants contains the acrid principle, as is shown by the stinging taste, and sense of heat in the stomach. The distilled water of the R. *sceleratus* yields crystals. The juice of the plants is a powerful vesicant, and prior to the introduction of cantharides was used by medical men for this purpose. It is now so used to produce ulcers on the legs by mendicants and malingerers in the army. The distilled water of the R. *flammula* is an effectual and speedy emetic; and was greatly

commended by Dr. Withering as preferable to any other when the object is to produce a quick evacuation of the stomach. The bruised leaves, too, are used as vesicants.

The *symptoms*, *post-mortem appearances*, and *treatment* of poisoning by the ranunculi are those of irritant poisoning (p. 358).

BRYONY.—The two plants which bear the common name of Bryony, have a certain importance as poisons, partly on account of their strong irritant action, and partly from their common presence in our woods and hedge-rows. Though they bear the same English name, they do not even belong to the same natural order, the White Bryony being the solitary representative among our common wild plants of the Cucurbitaceæ, while the black bryony belongs to the Dioscoreaceæ.

The *White Bryony* (Bryonia dioica, or wild vine) is very common in our woods and hedges, twining among trees and bushes, and clinging by its tendrils. The leaves are rough, the flowers small and of a faint green colour; the berries clustered, and, when ripe, red, filled with a fœtid unpleasant juice, and containing six seeds; and the root spindle-shaped, fleshy, and pale in colour, often attains a considerable size and thickness. Fig. 185 shows a cutting of the plant, with a small cluster of berries.

Fig. 185.

The root of this plant was formerly in use as a medicine, and was known to occasion vomiting and purging, with symptoms of collapse, sometimes ending fatally. The berries, when eaten by children, have caused vomiting.

The Black Bryony (Tamus communis) is also very common in woods and hedges, twining, without the aid of tendrils, and contrasting strongly with the white bryony in its leaves, which are heart-shaped, pointed, smooth, and shining; in its berries, which are ovoid; and in the colour of its root, which is black. The berries are in clusters, and when ripe, are like those of the

Fig. 186.

white bryony, of a red colour. A cutting of the plant, with a cluster of berries, is shown in fig. 186. The root of this plant has also been used as a cathartic, and the berries have made children sick.

Besides the vegetable irritants briefly noticed in this chapter, there are others of less importance, of which it must suffice to append a list. Some of them have produced the effects of irritants in the human subject, and have proved fatal, while others are inferred to be poisonous from their effect upon animals, or from direct experiment. A minute description of these poisons and of their effects must be sought for in works on Toxicology. Most of them will be found figured, with brief descriptions of their effects, in Johnson's 'British Poisonous Plants.' The following is the list in question :—Anemone pulsatilla, or pasque flower (also the A. nemorosa, A. hortensis, and A. coronaria, with other species); Caltha palustris, or marsh marigold; Chelidonium majus, or celandine; Daphne laureola, or spurge laurel; Euphorbia lathyris, or caper spurge (also other species, as the E. officinarum (fig. 187), peplus, and helioscopia); Gratiola officinalis; Hyacinthus nonscriptus, or wild hyacinth; Mercurialis perennis, or herb mercury; Narcissus poeticus, and N. pseudo-narcissus, or daffodil; Rhus radicans, and toxicodendron; Paris quadrifolia (fig. 188), Sedum acre; Delphinium staphysagria, or stavesacre (interesting as yielding the alkaloid *delphinia*); and the Sambucus nigra, or elder, the leaves and flowers of which, in Christison's experience, caused dangerous inflammation of the mucous membrane of the bowels, lasting for eight days. Two tablespoonfuls of the root of the Dwarf Elder (*S. edulus*) have also proved fatal to a woman fifty-four years of age.

Fig. 187.

Fig. 188.

A

Besides the foregoing, which are indigenous plants, the Jatropha curcas, or physic nut of the West Indies; and the Hippomane mancinella, or manchineel, with other species of the same (as the H. figlandulosa, and H. spinosa), may be mentioned as possessed of highly irritating properties. (See Christison, chapter on Vegetable Acrids.)

Most of the plants in the foregoing list act as simple irritants; but there are a few, such as the Mercurialis perennis, and Paris quadrifolia (fig. 188), which produce mixed symptoms of intestinal irritation and narcotic poisoning; and would, therefore, claim to be placed among the narcotico-acrid poisons of the earlier toxicologists.

V. DISEASED AND DECAYED VEGETABLE MATTERS.

A few cases have occurred of poisoning by spoiled vegetables; and bread made of wheat, rye, or barley, when spoiled or mouldy, has been known to act as an irritant poison, causing flushed face, dry tongue, acute colic pains, urgent thirst, and headache, vomiting and purging, exhaustion and drowsiness.

The *treatment* proper to such forms of poisoning consists in the prompt use of emetics, followed by aperients, of which castor-oil is the best.

CHAPTER XVII.

ANIMAL IRRITANTS.

I. CANTHARIDES.

II. DISEASED AND PUTRID ANIMAL MATTER.

III. TRICHINIASIS.

IV. POISONOUS FISH. V. VENOMOUS REPTILES AND INSECTS.

I. CANTHARIDES.

THE Cantharis vesicatoria, Spanish fly, or blister beetle, is distinguished by the shining metallic green colour of the head, legs, and wing-cases. It contains a strong irritant poison, characterized by its energetic action on the urinary and generative organs, and is the active ingredient of several preparations of the British Pharmacopœia.* The powder and tincture have been given to procure abortion, for lascivious purposes, or merely for a joke; and both powder and plaster have been taken by mistake. Its preparations have also produced severe effects on the urinary and genital organs when applied externally. The fly owes its poisonous property to an active crystalline principle, *cantharidine,* of which one grain is yielded by half an ounce of the powder, and the hundredth part of a grain will raise a blister on the lips.

The powder and the plaster are readily identified by the small shining golden or green particles which they contain; and the powder by the simple test of heat. If so small a quantity as the hundredth part of a grain be treated in the manner described at p. 384 (fig. 47), as soon as the temperature is raised to about 212° Fahr., a white sublimate appears on the disk of glass; and this, when examined under the microscope, is found to consist of crystals of cantharidine. If, however, the sublimate should be amorphous, or indistinctly crystalline, the characteristic crystals may be made to appear by treating the spot with ether. Much less quantities than the hundredth of a grain of the powder will

* Of the tincture, containing grs. vss to the ounce; of the acetum (℥ij to Oj); of the ointment (1 to 7); of the plaster (1 in 3); of the emplastrum calefaciens (1 in 24); of the liquor epispasticus (℥ij to ʒv); and of the charta epispastica (1 in 10½). The tincture is given internally in doses of 5 to 20 minims, the other preparations are for external use.

yield the characteristic sublimate, and it may be procured from the five hundredth, or even the thousandth of a grain. The low subliming temperature, absence of colour, and more or less distinctly crystalline form of the sublimate, taken together, are strikingly characteristic of this powder.

Symptoms.—Soon after swallowing the poison there is a burning pain with constriction of the mouth and throat, quickly followed by a similar burning sensation in the pit of the stomach, increased by pressure, and extending at length over the whole abdomen, accompanied by excessive pain in swallowing, dryness of the fauces, great thirst, copious discharge of blood or bloody mucus from the stomach, mixed with shining green particles, and, in less quantity, from the bowels; tenesmus, pain in the loins, distressing strangury, bloody stools and urine, and priapism, with swelling and inflammation of the genital organs. The patient is extremely restless, the breathing laborious, and the pulse quick and hard. Sometimes headache, delirium, and convulsions, tetanic spasms, symptoms allied with those of hydrophobia, and coma are superadded.

Among the occasional symptoms are blisters of the mouth, salivation, vomiting of tenacious mucus of the shape of the gullet, or of the mucous membrane itself, redness of the eyes, and lachrymation, and albuminous urine.

The tincture, in small doses of four or five drops, produces a marked effect on the urinary organs, curing incontinence of urine, sometimes without causing pain. On the other hand, very large quantities, as six ounces of the tincture, or two drachms of the powder, have been taken without bad effect, a fact only to be accounted for by the badness of the preparation.

Fatal Dose.—One ounce of the tincture. The fatal dose of the powder is not ascertained. Two doses of twenty-four grains each, taken at an interval of a day, have destroyed life, after producing abortion.

Fatal Period.—This poison is not speedily fatal. It usually destroys life in from twenty-four to thirty-six hours, but may be fatal after some days of suffering.

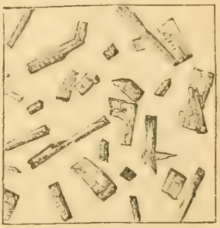
Post-mortem Appearances.—Marks of inflammation in different degrees and stages in the whole length of the alimentary canal, and in the urinary and genital organs. The stomach is inflamed, and may be gangrenous, in patches, where the powder has adhered; sometimes it is abraded, sometimes softened. The brain has been found gorged with blood, and the genital organs gangrenous. The powder may be found in the stomach for long periods after death. When given in powder, or taken as plaster, the blistering fly may be detected in the contents of the stomach

by the glistening golden or green colour of some of its particles, which may be readily seen by the lens or microscope. These particles may be collected, dissolved in ether or chloroform, evaporated to the thickness of an extract, and applied to the skin, or lip. If a blister is raised, it gives convincing evidence of the presence of cantharides. By these two tests Barruel detected cantharides in some cakes of chocolate, of which a part had been maliciously given to several persons. The sublimation by heat, as just described, is, however, much more delicate and satisfactory.

Sometimes, when the stomach has been discharged by vomiting, or the bowels emptied by aperients, the poison adheres to the coats of the stomach and intestines, and should be sought after in manner recommended by Poumet.* The intestinal canal having been detached, is distended with air, suspended and put on the stretch by a weight, and dried. Portions of the dried stomach and intestines are placed on sheets of glass, and carefully examined. The shining green spots are thus readily seen. M. Poumet has detected them seven months after interment.

Treatment.—There is obviously no antidote to this poison. Vomiting is to be excited and encouraged by emetics and warm liquids; and the poison to be removed from the bowels by full doses of castor oil. The free use of diluents, with oily or demulcent injections into the rectum and bladder, and leeches or bleeding, if the inflammatory symptoms run high, constitute the remainder of the treatment. Laudanum may be advantageously added to the injections, or suppositories of opium may be introduced into the rectum.

Fig. 189.

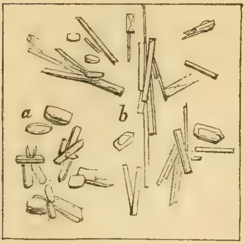


Cantharidine.—This is sold in the form of sparkling colourless crystals, which, when examined by the microscope, are found to consist of plates of various forms, lengths, and thickness.

Fig. 189 is taken from a good commercial specimen. It retains similar forms, but more delicate, and with some variety of grouping, in deposits from its solutions in ether and chloroform, and in its sublimates. The deposits from ether commonly assume the form of long quadrangular plates, those from chloroform of square plates and shorter oblongs. Fig. 190 shows the two forms most common in the sublimates—namely, the short plates (*a*), and the long plates (*b*). It is taken from photographs.

* 'Annales d'Hygiène,' 1842, p. 347.

Fig. 190.



× 50.

Cantharidine, when heated in the manner described at p. 384 (fig. 47), sublimes without residue, or with a faint stain only, and settles on the glass disk in such forms as those shown in fig. 190. It may be wholly dissipated without liquefying; but if the heat be applied suddenly it melts. When treated in the manner described at p. 386, it is found to sublime at 212° Fahr.

The action on cantharidine of sulphuric acid distinguishes it from almost all the active principles of vegetable origin. The acid produces no change of colour in it even when warmed and heated. Nor is its colour changed by nitric acid. These two negative reactions taken together distinguish cantharidine from every poisonous alkaloid or analogous active principle.

It will be observed also that cantharidine differs from the vegetable alkaloids and glucosides in leaving no deposit of carbon when heated, and that in the temperature at which it sublimes, as well as in the form of its sublimate, it differs from the mineral poisons, arsenious acid, and corrosive sublimate.

II. DISEASED AND PUTRID ANIMAL MATTER.

There is a disease prevalent among cattle in some parts of the Continent, but less known in England, which consists in the formation of large boils upon different parts of the body. The flesh of animals dead of this disease has often produced severe effects by contact with the skin, and when eaten has destroyed life either by producing violent cholera, or by creating a similar disease to that under which the animal laboured. The glanders communicated to man from the horse, and the diffuse inflammation excited by punctured wounds inflicted in dissection, or in preparing meat for the table, are familiar examples of the effect of diseased animal matter applied externally to the human body.

Putrid Animal Matter may cause severe and dangerous symptoms of irritant poisoning. The articles of food which have most frequently acted as poisons are sausages (especially those made of liver and blood), bacon and ham, cheese, and goose grease. The poisonous quality of the food appears to be developed only in the first stages of putrefaction.

The *symptoms* rarely come on till the lapse of three or four

hours. In some instances the irritation of the alimentary canal is accompanied by symptoms of collapse, in others by narcotic symptoms.

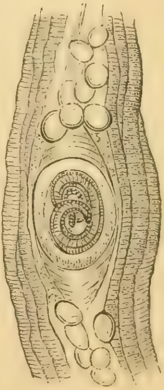
The milk of cattle fed in pastures containing poisonous plants, the flesh of game which has fed on certain berries, and the honey of bees collected from poisonous flowers, produces delirium and symptoms of narcotic poisoning.

The *treatment* of these cases, after the removal of the poison from the stomach, would be determined by the nature of the symptoms present.

III. TRICHINIASIS.

It has now been well ascertained that a very formidable malady in man and the domestic animals, is due to the reception into the stomach of the ova of the entozoon known as the *Trichina spiralis.* The vehicle by which they are conveyed into the stomach is the raw or imperfectly-cooked flesh of pork, whole or made into sausages. It is in Germany that this disease has been most frequently observed; but several cases have occurred in England. In Germany it has more than once appeared as an epidemic; and in Hettstädt, in Prussia, no less than eighty persons in a population of about 5500, were attacked by the disease through eating badly-cooked sausages, made from meat infected with the parasite. Eighteen or twenty persons had died before the subject became properly understood. The disease is so common in Germany that Dr. Zenker, of Dresden, was able to find trichinæ in as many as one in every thirty-four bodies inspected by him.

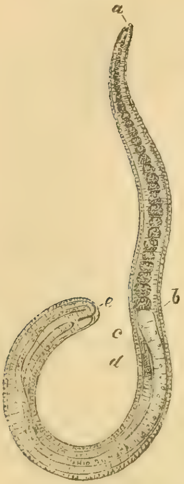
Fig. 191.



× 50.

The trichinæ begin to be developed very soon after their introduction into the stomach; males, females, and embryos in very large numbers being produced in the intestinal canal, and thence finding their way into the muscles, where they become encysted and inert. They are seen in the muscles, between the bundles of fibres, as opaque white specks. Fig. 191 shows the trichina coiled up within its cyst, with groups of fatty cells at either end; while fig. 192 exhibits it removed from its cyst. In this figure *a* represents the mouth, *b* the commencement of the alimentary canal, *c* and *d* a tubular sac, with dark granular

Fig. 192.



body, extending to the anal extremity at *e*.*

Symptoms.—In many cases the disease sets in with diarrhœa. There are extreme weariness and depression, loss of appetite, sleeplessness, febrile symptoms, severe pains in the muscles, with sometimes œdematous swelling of the joints, followed occasionally by painful persistent contractions of the flexors of the limbs. In some instances, typhous symptoms come on, and the patient dies unconscious; but the more common termination is by pneumonia. In fatal cases death occurs within a month of the ingestion of the food containing the parasite.

Post-mortem appearances.—The muscles are found of a pale reddish-grey colour, speckled with small lighter coloured spots, which are found to be the trichinæ in all stages of growth. They are found in all the voluntary muscles, and in the heart.

Treatment.—There is no remedy for the disease. The existence of trichinæ should inspire caution in selecting pork for food, and in rejecting as dangerous pork and sausages which have not been properly cooked.

IV. POISONOUS FISH.

Some fish are constantly poisonous, others only occasionally so, and others again, or parts of them, act injuriously on certain persons only.

The most important of these is the common *mussel*, which becomes poisonous in certain circumstances not yet well understood.

The symptoms generally show themselves after one or two hours with swelling and itching of the eyelids, and watering of the eyes, and an eruption on the skin, in most cases closely resembling common nettle-rash, and attended with intense heat and itching. Dyspnœa generally follows, but occasionally precedes, these symptoms; there is extreme weakness; and in fatal cases delirium, convulsions, and coma have supervened. Symptoms of irritation of the stomach are not always present, but in some

* See Griffith and Henfrey's 'Micrographic Dictionary,' art. Trichina.

instances there have been nausea, pain in the pit of the stomach, vomiting, and difficulty in swallowing.

The treatment consists in the free use of emetics, purgatives, and diluents. Ether may be given with advantage.

Instances are on record in which oysters, eels, and salmon have produced injurious effects. The richer fish also habitually disagree with some persons.

V. VENOMOUS REPTILES AND INSECTS.

As no difficult medico-legal questions arise out of the poisonous effects produced by the insertion of the various secretions of animals into wounds, whether inflicted by the fangs of serpents, the stings of insects, or the claws of such creatures as the ornithorynchus, or (as in the case of the cutaneous secretion of the common toad) inoculated for the purpose of experiment, this subject will be very briefly noticed.

In England we have but one venomous snake, the common viper, or adder (Vipera berus). It is about two feet long, has a brown body, slate-coloured belly, rhomboidal dorsal scales, with a row of black spots on each side, head covered with rough scales, and poisonous fangs in the upper jaw. It appears, however, that it is subject to differences of colour; for Dr. Stephenson, in his 'Medical Zoology and Mineralogy' (p. 66), figures two adders found near Harrow-on-the-hill, the one brown, the other blue-black.

The *symptoms* caused by the bite of the adder are sharp pain in the wound, swelling, redness passing into a livid hue, and rapidly extending to adjoining parts. Blisters form round the wound, like those of a burn. The pain soon abates, the parts affected become œdematous and livid, and large livid spots appear on the surface. The general symptoms, which commonly show themselves within forty minutes of the bite, consist of anxiety, prostration, cold sweats, and feeling of giddiness and faintness; bilious vomiting and diarrhœa; quick, small, and irregular pulse, and difficult breathing; to which are sometimes added convulsions, and disturbance of the mind.

The *treatment* consists in the immediate application of a ligature between the wound and the heart, and the removal of the poison by suction. Ammonia should be applied to the wound and given internally. Tincture of iodine is found to be a useful application to the stings of venomous insects, and might be usefully applied to the wound of the viper.

CHAPTER XVIII.

DIAGNOSIS OF THE POISONOUS ALKALOIDS, AND ANALOGOUS ACTIVE PRINCIPLES.

In the later chapters of this work, which treat of the organic poisons, several active principles derived from organic matters have been more or less minutely described; but no fitting opportunity has occurred of so comparing them with each other as to bring into relief the properties by which they are respectively characterized. An attempt will now be made to supply this deficiency in the case of those active principles which are most important in a toxicological point of view.

Those selected for comparison are Cantharidine from the animal kingdom; and Atropine, Aconitine, Brucine, Coniine, Digitaline, Morphine, Nicotine, Picrotoxine, Solanine, Strychnine, and Veratrine, from the vegetable kingdom. Of these, ten are solid stable compounds, and two only (Coniine and Nicotine) liquid and volatile. If grouped in accordance with their ultimate chemical composition, they will be found to consist of three classes—namely, those that contain—

1. Carbon, Hydrogen, and Oxygen.
2. Carbon, Hydrogen, and Nitrogen.
3. Carbon, Hydrogen, Oxygen, and Nitrogen.

To the first class belong the animal product, Cantharidine, and the two *Glucosides*,* Picrotoxine and Digitaline; to the second Coniine and Nicotine; and to the third, the *alkaloids*, Atropine, Aconitine, Brucine, Morphine, Solanine, Strychnine, and Veratrine. Of these, however, solanine has been by some chemists classed with picrotoxine and digitaline among the glucosides.

It is worthy of note that the chemical composition of these substances does not materially influence their reactions. Thus, the animal product cantharidine differs in its reactions from the vegetable glucoside picrotoxine as much as the alkaloids strychnine and veratrine do from each other; though cantharidine is distinguished from picrotoxine only by containing, in 100 parts,

* Glucosides are named from the presence of glucose, or grape sugar, among the elements of their decomposition.

one more of hydrogen, and one less of oxygen; while strychnine differs from veratrine by an excess of carbon amounting to 13 per cent., and a defect in hydrogen and oxygen of 6 and 7 per cent., respectively. So also with morphine and brucine: their reactions are widely different, and yet the former has only one per cent. more carbon, and one per cent. less nitrogen. The only good ground, therefore, for separation between one group and another is that of physical difference. The fixed alkaloids and glucosides may therefore conveniently form a larger group, the volatile alkaloids a smaller one, claiming to be examined separately.

I. THE FIXED ALKALOIDS, ETC.

Following the course which has been already adopted in respect of these bodies individually, they will be treated of as they present themselves in medico-legal inquiries.—1. *In substance.* 2. *In solution.* 3. *In organic mixtures.*

1. In substance.—We may be greatly assisted in distinguishing the substances included in this list—*a.* by inspection and microscopic examination; *b.* by the effect of heat, including the odour of their vapour; *c.* by the temperature at which they sublime; *d.* by the character of their sublimates, and the reaction of the same; *e.* by the effect of sulphuric and nitric acids; and *f.* by their solubility in various menstrua.

a. On inspection, commercial atropine, cantharidine, morphine, picrotoxine, and strychnine are obviously crystalline: aconitine, brucine, digitaline, solanine, and veratrine amorphous. With the exception of digitaline, which is buff-coloured, they are either colourless, or slightly tinted. When examined by the microscope, aconitine, digitaline, and veratrine still appear amorphous: brucine, cantharidine and solanine show thin mottled plates; and atropine, morphine, picrotoxine, and strychnine long prisms (atropine and strychnine square, morphine six-sided, picrotoxine flattened). It may be well to add that aconitine may be obtained in crystalline masses and detached crystals; while morphine and strychnine are sometimes sold as powders.

b. When heated on a porcelain slab, the several substances on the list behave as follows:—*Aconitine* liquefies very readily, into a yellow fluid, smokes slightly, and spreads into an abundant ash: odour not disagreeable. *Atropine* liquefies very readily into a pale fluid, and leaves a light brown stain: odour as of singeing, not disagreeable. *Brucine* liquefies readily into a pale fluid, darkens, gives out an abundant smoke, and swells into a moderately bulky ash: odour as of burnt horn. *Cantharidine* rises

in vapour, with slight irritating odour of singeing; melts at a higher temperature, leaving no ash. *Digitaline* darkens, melts slowly into a brown liquid, smokes abundantly, leaves a black swollen ash: odour of the drug. *Morphine* sublimes before melting, liquefies slowly into a black fluid, dries and melts again, gives out a dense smoke, and swells into an abundant ash: odour as of singeing. *Picrotoxine* melts slowly, smokes slightly, leaves a scanty ash: odour slight, as of singeing. *Solanine* discolours, melts very slowly, smokes abundantly, swells and spreads into a bulky ash: odour as of baked apple. *Strychnine* sublimes before melting, liquefies slowly into a dark brown fluid, gives off a dense smoke, and leaves a moderately bulky ash: odour, aromatic and agreeable. *Veratrine* liquefies readily into a yellow fluid, gives off an abundant vapour, spreads into a bulky carbonaceous layer: odour as of mice, and irritating.*

c. There is reason to believe that the subliming temperature of the alkaloids will prove one of our best tests. I have ascertained with respect to the substances in the list, the facts which, with the subliming temperatures of a few of the more important inorganic poisons, make up the following table:—

1. Sublime as white vapour, without change of form or colour.	Corrosive sublimate			200°
	Cantharidine			212°
	Calomel			210°
	Arsenious acid			280°
			Sublime.	*Melt.*
2. Sublimes without change of colour, and is wholly dissipated in vapour.	Oxalic acid		180°	280°
3. Sublime, melt, and yield carbonaceous residue.	Morphine		330°	340°
	Strychnine		345°	430°
			Melt.	*Sublime.*
4. Melt, change colour, sublime, and deposit carbon.	Aconitine		140°	400°
	Atropine		150°	280°
	Veratrine		200°	360°
	Brucine		210°	400°
	Digitaline		310°	310°
	Picrotoxine		320°	320°
	Solanine		420°	420°
		Decrepitates.	*Sublimes.*	*Chars.*
5. Decrepitates, sublimes slowly and scantily, and chars.	Tartar emetic	380°	480°	550°

* It should be noted that the odour varies somewhat with the quantity of the alkaloid, the stage of the sublimation, and the distance from the nostrils.

d. Aconitine, brucine, and *digitaline,* do not yield crystalline sublimates; *atropine* yields branching figures, and, at favourable temperatures, prisms and plates; *cantharidine* very constantly yields jointed plates and prisms; *morphine* yields compound floreated crystals, with curved lines, and, at favourable temperatures, prisms and needles; *picrotoxine,* at favourable temperatures, yields needles, at ordinary temperatures, amorphous sublimates; *solanine* yields bundles of crossed needles (very characteristic); *strychnine,* at ordinary temperatures, gives compound crystals, in which straight or slightly curved lines predominate, as latticed and feathery forms, but at higher temperatures, four-sided prisms and other defined and detached crystalline forms; *veratrine,* when the sublimation is successful, yields detached crystals, among which octahedra are to be found.

Of the process of sublimation generally it should be observed, that the best results are obtained when the superimposed disk (fig. 47, p. 384) is heated to near the point at which the vapour would be driven off, and the less favourable results when the disk is less heated.

The reactions of the sublimates are similar to those that are obtained with the solutions of the substance itself. Thus, strychnia-sublimates respond well to the colour tests, and give characteristic reactions with carbazotic acid and bichromate of potash, while morphia-sublimates respond to the ordinary tests for morphia, and yield several well-marked and characteristic reactions (see pp. 499 and 541). The crystals of cantharidine, solanine, and veratrine, are characteristic, the less successful sublimates of the last-named alkaloid responding readily to the test of sulphuric acid.

e. The effect of sulphuric acid (cold, warm, and hot), and of nitric acid, on the substances in the list, is seen at a glance in the table subjoined.

The small figures attached to the words in this table show degrees of intensity. Thus the figure [1] added to the words "yellow" and "pink" in the second line indicates a slight tinge of those colours, the tinge of pink in the case of strychnine being due to a trace of brucine. It will be seen that the table is so arranged as to distribute the ten substances into four classes, and that every substance in the table is distinguished by the effects produced by the succession of tests. Cantharidine is marked by its negative reactions; brucine is distinguished from strychnine, and morphine from atropine, by the effect of nitric acid, the remainder from each other by the action of sulphuric acid alone; the members of the second group are marked by a

	Sulphuric Acid.			Nitric Acid.
	Cold.	*Warm.*	*Hot.*	
Cantharidine . .	0	0	0	0
Strychnine. . .	0	0	yellow[1]	pink[1]
Brucine. . . .	0	0	yellow[2]	red[3]
Morphine . . .	0	0	brown	orange[3]
Atropine . . .	0	0	brown[3]	0
Aconitine . . .	0	brown	black	0
Picrotoxine. . .	0	yellow	brown	0
Veratrine . . .	orange[3]	scarlet	claret	0
Digitaline . . .	red-brown[1]	red-brown[2]	red-brown[3]	0
Solanine . . .	yellow[3]	brown[2]	brown[3]	0

negative reaction with cold and warm sulphuric acid; those of the third group by a negative reaction with the cold acid; those of the fourth group by the change of colour wrought by the cold acid. The sulphuric acid solutions, when warmed and heated, give off vapours which have not the same odour as that of the same substances when simply heated; and they are more irritating. In some notes of the reactions of the alkaloids with which I have been favoured by Dr. Silver, for instance, atropine and daturine, treated by sulphuric acid, and heated, are stated to evolve an odour resembling wild honey, or preserved rose leaves. The odour of heated atropine does not answer to this description.

f. The solubility of these poisons in the several menstrua while it may be made to contribute to their diagnosis, may also assist us in devising the best methods of procedure in order to extract them from organic liquids. In the following summaries the poisons are placed in the order of their solubility, beginning with the most insoluble. The figures (from Wormley) show the number of parts of the several menstrua required for solution.

WATER (*cold*):—Strychnine (8333); veratrine (7860); morphine (4166); aconitine (1783); solanine (1750); brucine (900); atropine (414); picrotoxine (150); digitaline very soluble.

ETHER:—Solanine (9000); morphine (7725); strychnine (1400); aconitine (777); brucine (440); veratrine (108); atropine; picrotoxine; digitaline very soluble.

CHLOROFORM:—Solanine (50,000); morphine (6550); strychnine (8); the rest freely soluble.

Absolute Alcohol.—Strychnine insoluble; brucine soluble.

AMYLIC ALCOHOL: — Solanine (1061); digitaline sparingly soluble; morphine (133); strychnine (122); veratrine, brucine, atropine, aconitine, and picrotoxine, freely soluble.

Benzole.—Solanine insoluble; the remainder freely soluble.

2. IN SOLUTION.—The alkaloids do not often present themselves for examination in a state of solution; but we may have to deal with solutions of their salts. When we have to do with a liquid which we suppose to be a solution of one of these salts, we first expose a drop of the liquid on a glass disk or slide to the vapours of ammonia. If the liquid grows white and turbid, we examine it by the microscope, and find crystals forming in it; but if the change is less marked, we examine the dried spot. The discovery of crystals, such as those depicted in fig. 103, p. 498, would furnish a strong probability of morphine; crystals resembling those of figs. 129, 130, p. 539, of strychnine; the crossed needles and tufts of fig. 144, p. 554, of brucine. If among the precipitates thus obtained there is one of moderate size and thickness, it should be submitted to the test of sublimation at ascertained temperatures (p. 384); and the sublimate being first examined by the microscope, should then be tested under the microscope. Another spot may be treated by a droplet of glacial acetic acid, and then diluted with a small quantity of distilled water. This solution is well suited to the application of the liquid tests of which a list has been given at p. 547. A drop of this acidified aqueous solution should be placed on a series of glass disks or slides, each of the reactions as they occur being observed under the microscope.

With respect to these reactions with the liquid tests, the following general statements may be premised with advantage:—

1. With *strychnine* many of the reactions are *instantaneous*, the rest quick in making their appearance; and they all, with the one notable exception of tannin, consist of crystalline forms. 2. *Brucine* holds the next place in these respects, being scarcely inferior to strychnine. 3. *Morphine* yields the palm to both the foregoing, not more than half of its reactions being distinctly crystalline. 4. *Atropine* yields much less satisfactory results than morphine. 5. *Veratrine* gives dense precipitates with more than half the reagents, but no characteristic crystals. 6. *Aconitine, cantharidine, digitaline, picrotoxine*, and *solanine*, have no satisfactory reactions with the liquid tests.

It appears then that *strychnine, brucine*, and *morphine*, are the three alkaloids which most frequently yield crystalline forms with liquid reagents. They may, therefore, be advantageously selected as affording good illustrations both of the right mode of

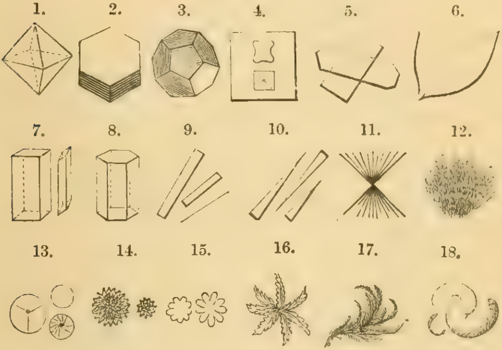
procedure in applying liquid tests, and of the diagnostic value of the method. The usual way of applying liquid tests to a solution contained in a test-tube is not only wanting in delicacy, but fails to display the most characteristic features of the reaction. It enables us to say whether there is, or is not, any precipitate, and to describe in very general terms its consistence and colour. But, in order to make the most of the method of liquid reaction, as well as to operate with the smallest quantities, the proper course is to place a drop of the liquid containing the alkaloid on a glass disk or slide, to add a drop of the liquid reagent, and to note first the immediate or proximate effect; then the change that takes place after such an interval as half an hour or an hour; and, lastly, the character of the dry spot left by the evaporation of the liquid: these several observations to be made under the microscope. But before we proceed to apply the tests, we ought to have a more definite notion than is generally entertained of the characters of crystalline deposits, and of the features by which they are to be identified.

When a drop of a solution of an alkaloid is placed on a glass disk or slide, and treated with a drop of a liquid reagent, the immediate effect is the production of a precipitate, more or less dense, or a slight opalescence; or the solution may retain a perfect transparency. The dense precipitate, when examined by the microscope, is either amorphous and so continues till it dries, or it consists of a gelatinous or curdy matter, out of which well defined crystals more or less quickly develope themselves, some floating on the surface, some attaching themselves to the glass, some occupying the depth of the liquid. The opalescent liquid, when examined by the microscope, is found to owe its change of appearance to the instantaneous development of crystals, and this may even occur in a drop which does not seem to have undergone any change. If the reactions are examined after the lapse of an hour or less, some precipitates are found to have undergone no change, others to have passed from the amorphous to the crystalline form; and sometimes the drop, which was quite clear at first, grows more or less turbid from the slow formation of crystals. If, lastly, the spot is examined in its dry state, it will be found to consist of the amorphous precipitate unchanged from the first; or of crystalline forms, central, marginal, or both, mixed, when the solution and the liquid reagent do not happen to have been well proportioned, and the reagent is a saline solution, with crystals of the unexpended reagent.

Now a very slight familiarity with microscopic crystals teaches the somewhat discouraging lesson that, obtain them as we will—

by sublimation, by liquid applications to dried spots, or by reaction of liquid with liquid—we cannot secure uniformity of appearance, or even the certain production of the crystalline form. More extended experience, however, removes some part of the difficulty by teaching us that many perplexing differences of form arise out of the various groupings of the same elementary crystal. So that we have only to ascertain by repeated experiment and microscopic examination what that elementary crystal is, and our difficulty is at an end. This subject will be better understood if the leading crystalline forms which we encounter in the course of our examination of organic poisons are first brought together, as in fig. 193.

Fig. 193.



Forms 1, 2, and 3 have been already described (p. 545) as occurring in deposits from a solution of *strychnine* in benzole. The square plate (4), often modified by indentation and cross marking, as in the small enclosed figures, occurring in union with variously formed groups of plates and needles (9), are quite characteristic of the *instantaneous* reaction of bichromate of potash and *strychnine*, and of the slower reaction of the same alkaloid with bichloride of platinum. The long rectangular plates (9) variously crossed and grouped are equally characteristic of the *instantaneous* reaction of *strychnine* and the sulphocyanide of potassium; and also of morphine with tannic acid—the former of rare length and beauty, and disposed in groups, the latter much smaller, and usually detached. The wide oblong plate variously truncated (5), and disposed in groups, belongs to

the reactions of brucine with sulphocyanide of potassium, and with corrosive sublimate; while the leaf-like or winged form (6) blended with oblong plates (5) mark the quick reaction of *brucine* and ferricyanide of potassium, in which the iridescent colours of the thin curved plates projecting into the liquid at every angle, irresistibly remind us of some of the most delicate and beautiful of insect forms. The square prisms (7), and the hexagonal prism (8), have been already figured as belonging to strychnine and morphine respectively; and the flattened prism (7) as the form of oxalic acid. The pointed crystals (10) are seen in perfection in the reaction of strychnine and the spirituous solution of iodine with sulphuric acid. The double group of needles radiating from a point (11) occurring, as it does, with crystals of straight and curved outline (5 and 6) in the reaction of brucine with the red prussiate of potash, is eminently characteristic. Such forms radiating from a point are common in many marginal crystals—e.g., *strychnine* with iodo-iodide of potassium, and *morphine* with hydrochloric acid. Tufts (12) are not uncommon in deep drops, when in shallower ones groups of needles or fine prisms abound. The disks faintly marked (13), thicker and coarser (14), and with curved edges (15), are to be found blended with other crystalline forms; those of (15) being common in the reaction of strychnine with permuriate of iron. The star-fish crystal (16) is seen of large size and perfect form in the reaction of *brucine* with nitro-prusside of sodium. The dendritic or arborescent form (17) occurs in the reaction of *strychnine* with terchloride of gold, and in a marked manner with carbazotic acid, the elementary form which specially marks that reaction being the curved claw-like figure (18). Dendritic forms are also common in deposits from crystalline solutions.

Several of these reactions are here mentioned for the first time; but not till after repeated experiment and large comparison with other reactions. The reactions of strychnine with bichromate of potash and ferricyanide of potassium admit of complete identification by a simple modification of the colour test. The chief result of the two reactions being crystals formed by the union of strychnine with the bichromate of potash and ferridcyanide of potassium (two of the colour-developing substances named at p. 540), the addition of strong sulphuric acid is all that is required to complete the colour test. If then a droplet of sulphuric acid be placed at the margin of the crusts so as to blend slowly with the crystals, the characteristic rich blue tint passing to mulberry and light red will be developed as each group of crystals is touched by the acid; and if this reaction be watched under the microscope, it will be found to continue for several

minutes. When the dry spot of brucine is similarly treated, the acid brings out an orange tint fading to light yellow, while the dry spot of morphine shows no immediate change of colour. It is not possible to apply the colour tests for strychnine in a more conclusive manner.

3. In Organic Mixtures.—Most of the methods which have been employed for extracting the alkaloids from organic mixtures are founded on the principles first set forth by M. Stas, of Brussels, in the year 1851—principles which had already been practically applied in separating the alkaloids from the vegetable substances of which they form part. The alkaloids unite with acids to form salts which are soluble in water and also in alcohol; these salts are readily decomposed by the fixed alkalies or their carbonates, the acids combining with the new base thus presented, and the alkaloids remaining uncombined in the solution. Ether dissolves the alkaloid thus set free. The method of Stas, as applied to the fixed alkaloids, makes use of these properties. In extracting the two volatile alkaloids, the insolubility of their acid salts in ether is turned to account, the ether being employed to remove such organic impurities as are soluble in it, thus leaving the salt of the alkaloid, in a pure state, in the liquid.

The method founded on these principles consists of several distinct operations. 1. The organic matter treated with twice its weight of absolute alcohol, and from ten to thirty grains of tartaric or oxalic acid, is heated in a flask to about 160° Fahr. till brought to a state to pass the filter. The alcoholic acid mixture, being allowed to cool, is filtered, and the filtrate evaporated to dryness. 2. This residue, dissolved in a small quantity of distilled water, is then treated with bicarbonate of soda, and the alkaloid set free. 3. The resulting liquid, holding the alkaloid dissolved or suspended, is poured into a long tube with four or five times its bulk of ether, briskly shaken, and then left at rest. The ether floats on the surface holding the alkaloid in solution. 4. A part of this ethereal solution is now poured into a watch-glass and allowed to evaporate. It may have contained a *volatile* or a *fixed* alkaloid. If the former, oily streaks will appear on the glass; if the latter, a deposit with some traces of a crystalline formation. From this point the method of procedure will be determined by the indications thus obtained.

For the *volatile liquid alkaloids* the following procedure is required:—From fifteen to thirty grains of a strong solution of caustic potash or soda are added to the liquid in the tube, which is again briskly shaken, and then allowed to stand. The ethereal solution is next drawn off by a pipette, and shaken up with a

little water acidified with sulphuric acid. The ether is again drawn off, and leaves the alkaloid as sulphate in the water. The acid aqueous solution is now treated with excess of caustic potash or soda, and the alkaloid set free, to be again shaken up with ether and dissolved by it. On slowly evaporating the ethereal solution, the alkaloid may be obtained in a state of sufficient purity.

For the *fixed alkaloids* the process consists in treating the contents of the tube with the same quantity of a strong solution of caustic potash or soda, shaking briskly, causing it to stand till the ethereal solution has risen to the surface, drawing this off with the pipette, and allowing it to evaporate. The residue, which is either a solid or a thick milky liquid, is treated with a few drops of alcohol, and allowed to evaporate, when crystals of the alkaloid may be obtained. But if not, a few drops of water slightly acidulated with sulphuric acid are to be added, and the watch-glass carefully rotated. A soluble sulphate of the alkaloid is thus formed, which being carefully drawn off, or filtered, may be neutralized by a strong solution of carbonate of soda, the alkaloid set free, dissolved by absolute alcohol, and allowed to furnish crystals by evaporation.

This method of Stas for the fixed alkaloids has been simplified by Otto; also by Messrs. Rodgers and Girdwood, who employ hydrochloric acid instead of the tartaric or oxalic, and chloroform instead of ether. Professor Bloxam prefers benzole to chloroform, and Uslar and Erdmann use amylic alcohol; while for extracting strychnine from beer Professors Graham and Hofmann availed themselves of the property which animal charcoal possesses of separating the alkaloids from their solutions.*

II. THE LIQUID VOLATILE ALKALOIDS.

These alkaloids are distinguished from the fixed alkaloids by their liquid form, and from each other by several satisfactory tests.

The odour of coniine is like that of stale tobacco, or dead mice, while that of most, if not of all, specimens of nicotine is agreeable. If a drop of coniine is let fall on filtering paper, it forms a round defined stain of a clear yellow colour, while the stain of nicotine is darker and less clear, and may have a tint of green. If now a drop of distilled water is placed at the margin of the two stains, that of coniine remains intact, while that of nicotine

* For a more precise account of all the successive steps of extraction of the alkaloids, fixed and volatile, the reader must be referred to works on Toxicology, or to such special treatises as Dr. Wormley's 'Micro-Chemistry of Poisons,' p. 411, *et seq.*

is more or less completely dissolved. If, again, two watch-glasses are filled with distilled water, a drop of coniine will be found not to mix with it, but to form a greasy scum upon the surface; while a drop of nicotine will be seen to dissolve easily and completely.

Now place three drops from each watch-glass on six glass disks or slides, and add the following re-agents:—1. The bichloride of platinum. 2. Corrosive sublimate. 3. Carbazotic acid.

1. *Bichloride of Platinum.*—This gives an immediate visible precipitate with the solution of *nicotine*, but none with that of coniine. The precipitate examined under the microscope is flocculent, and after a time shows coarse dendritic forms.

2. *Corrosive sublimate.*—With *nicotine*, corrosive sublimate yields very distinct groups of truncated plates, radiating from a centre, or winged forms; with coniine, an amorphous precipitate.

3. *Carbazotic acid.*—With liquid solutions of the two alkaloids, this re-agent yields precipitates resembling those depicted at p. 558.

Lastly, coniine is distinguished from nicotine by giving with hydrochloric acid, or its vapour, groups of needles; and nicotine from coniine by assuming a blood-red colour with chlorine.

INDEX.

THE END.

LONDON:
SAVILL, EDWARDS AND CO., PRINTERS, CHANDOS STREET,
COVENT GARDEN.

Post 8vo, cloth, price 9*s.*

The Diseases of Infancy and Childhood. By THOMAS HAWKES TANNER, M.D., F.L.S., &c.

"We have much satisfaction in cordially recommending the book as one of the most careful, accurate, and accessible manuals."—*Edinburgh Medical Journal.*

Fcap. cloth, price 12*s.* 6*d.*

Druitt's Surgeon's Vade-Mecum: A Manual of Modern Surgery. The Ninth Edition, thoroughly Corrected, much Enlarged, carefully brought up to the Present Time, and Illustrated by 375 highly-finished Wood Engravings.

Fcap. cloth, price 12*s.* 6*d.*

A Manual of Human Anatomy. By ROBERT KNOX, M.D., late Lecturer on Anatomy in Edinburgh. Illustrated by 250 highly-finished Wood Engravings, the Vessels coloured.

"This is one of the most complete works on human anatomy which has issued from the press."—*Medical Times.*

The Seventh Edition, fcap. 8vo, cloth, price 12*s.* 6*d.*

Hooper's Physician's Vade-Mecum: A Manual of the Principles and Practice of Physic, with an Outline of General Pathology, Therapeutics, and Hygiene. Seventh Edition, greatly enlarged and improved, with many Wood Engravings. By W. A. GUY, F.R.C.P., Physician to King's College Hospital; and JOHN HARLEY, M.R.C.P., Assistant-Physician to King's College Hospital.

Fcap. cloth, price 12*s.* 6*d.*

Dr. Churchill's Theory and Practice of Midwifery. The Fifth Edition, corrected and improved, with extensive Statistics, and illustrated by 119 Wood Engravings.

Fcap. cloth, price 7*s.*

The Medical Vocabulary: containing a Concise Explanation of upwards of 10,000 of the Terms used in Medicine and the Accessory Sciences. By ROBERT FOWLER, M.D. Edin.

"It is copious enough to give all the more important phrases, and yet so moderate in size and price as to come within the means of every practitioner. We can heartily recommend the book."—*Medical Circular.*

Royal 32mo, cloth, price 5*s*. 6*d*.

Outlines of Elementary Botany. For the use of Students. Illustrated by 200 Wood Engravings. By ALEX. SILVER, M.A., C.M., M.D., Assistant Physician to Charing Cross Hospital.

"Dr. Silver's little book is likely to be very useful to the medical student."—*British and Foreign Medico-Chirurgical Review.*

Fcap. 8vo, cloth, price 8*s*. 6*d*.

Milne-Edwards' Manual of Zoology. Translated from the last French Edition by ROBERT KNOX, M.D. Second Edition, with many additional Observations, and illustrated by 572 highly-finished Wood Engravings. Edited by C. CARTER BLAKE, F.G.S., F.A.S.L.

"The translation of this admirable text-book cannot fail to prove in the highest degree serviceable, not merely to students of zoology, but to all who propose placing their general education upon a sound and liberal basis."—*Lancet.*

Second Edition, in royal 32mo, price 3*s*. 6*d*.

The Prescriber's Companion: containing a brief Description of all the Preparations and Compounds in the New Edition of the British Pharmacopœia, together with many others in general use, arranged alphabetically and printed in *colours* for easy reference, with Therapeutic Action, Incompatibles, and Doses for Adults and Children. Second Edition, much improved and greatly enlarged. By ALFRED MEADOWS, M.D., M.R.C.P., Physician to the General Lying-in Hospital, and to the Hospital for Women.

"It contains a large amount of information in a very short compass, and should be in the pocket of every practitioner."—*Lancet.*

Fcap. cloth, price 5*s*. 6*d*.

The Medical Officers' Vade-Mecum, or Poor-Law Surgeon's Guide: containing the Regulations at present in force relating to the Relief of the Poor in Sickness, and the Appointment, Qualifications, Duties, and Remuneration of Union Medical Officers in England and Wales; with a Note on Vaccination and Public Vaccinators. By NUGENT CHARLES WALSH, Esq., of the Poor-Law Board, Barrister-at-Law.

In 8vo, cloth, price 25*s*.

A Text-book of Physiology. By Dr. G. VALENTIN, Professor of Physiology in the University of Bern. Translated and Edited from the Third German Edition. By WILLIAM BRINTON, M.D., F.R.S., and illustrated by upwards of five hundred Illustrations on Wood, Copper, and Stone.